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CMFRI
वार्षिक प्रतिवेदन
Annual Report
2009 -10

केंद्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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Central Marine Fisheries Research Institute

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▪ Demersal Fisheries	:	Policy documents for Gujarat and Tamil Nadu; publication on lizardfish fisheries
▪ Crustacean Fisheries	:	Publication of book on prawn fisheries of India
▪ Molluscan Fisheries	:	Publication of gastropod operculum ID manual
▪ Fishery Environment Management	:	Digitization of historic data of marine environment and plankters (1950 onwards)
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PREFACE

Innovation is the key to sustainability and enhanced productivity in any production system. This is more relevant in the case of finite and exhaustible natural resources. The open access regime existing in the harvesting of marine fisheries resources in the country warrants stronger emphasis on invoking technological innovations as well as management paradigms that reconcile livelihood issues with concerns on resource conservation. It is heartening to note, with a sense of satisfaction and pride, that this year we could make salient achievements in this direction.

Open sea cage culture being perfected by us is an innovation system that aims to fulfill not only the fascination to farm the seas as a profitable aqua-venture but also as a potential tool for conservation mariculture. The successful replication of the innovation in different locations proves that it has captured the imagination of the coastal stakeholders. Innovations do not happen in a socio-political vacuum. It is the extent of partnership between the research and the client system that decides the fate of a technology in terms of its adoption or rejection. We need to build on the goodwill shown by the community in taking the innovation further.

Innovations like open sea cage culture should be treated like a jigsaw puzzle before it becomes eligible for a full-throated diffusional promotion. It is here that the success we have achieved in developing the hatchery technology for cobia attains significance. The success has widened the horizon of sea farming operations as we no longer have to compromise our ecosystem concerns while meeting the seed requirements.

For the last many years we have been making sincere efforts in moulding our R&D system responsive to market signals. With the receipt of the trademark "Cadalmin", we have in fact bolstered our efforts in this direction. The development of technology for making neutraceuticals from the mussel extract is the latest example of our continuing endeavour in this line. The mussel farming we have spearheaded will receive a shot in the arm once this technology reaches the level of commercial production, which is expected soon. Similarly, 'Varna' fish feed we have developed for marine ornamental fishes will provide an impetus to the ornamental fish entrepreneurs of our country.

Marine policy research in our country is at a nascent stage. Last year we had made a decision to engage proactively in this arena by bringing out a new series of publications tilted marine policy briefs. I am happy to note that we could make a

beginning by releasing two issues in the series, one for Kerala and another on Impact of seasonal trawling ban in India. We could also complete the required spadework for the Marine Fisheries Census 2010 in time. We have also made a successful beginning in our journey to accredit our Institute as the premier certification agency at global level for sustainable fishing.

This year we have taken a series of new initiatives for augmenting research and development in the marine fisheries sector. Having blazed an illustrious trail for more than six decades, CMFRI has initiated a new system of field information dispensation on a near real time basis. As the first phase of this effort, the landing figures and the landing centre price range of important resources at six major fishing harbours of the country are being published as "Fish Watch" in CMFRI website.

After its 56th year of publication, the *Indian Journal of Fisheries* is now indexed in Science Citation Index (SCI). The digital version of all CMFRI publications since 1954 has been prepared by our Library and Documentation Unit and arrangements are being made to keep digital version of more than one lakh pages of scanned documents *via* Internet. Another land mark in our progress is the launching of eprints@CMFRI, which is the Open Access research outputs repository of Central Marine Fisheries Research Institute. Research outputs of CMFRI - journal papers, conference papers, reports, theses, patents *etc.* are uploaded/self-archived by CMFRI scientists who do research on fisheries and related areas, which can be freely, downloaded and used by the interested users.

Our hard work and commitment to research programmes saw the successful broodstock development of Cobia in sea cages at Mandapam Regional Centre of CMFRI. Methods for induced breeding were also developed and successful spawning and larval production were achieved.

The prestigious frontier research projects under NAIP are progressing well and interface activities of KVK as well as ATIC are praiseworthy. I am happy to find that our knowledge base is expanding with inputs and achievements from the institute funded research projects.

I am sure we have moved many steps forward in fulfilling the mandated responsibilities bestowed on us. I congratulate the sincere and continuing efforts put forth by all members in the CMFRI fraternity in making our saga socially and scientifically relevant.

30th June, 2010
Kochi

G. Syda Rao
Director

कार्यकारी सारांश

वर्ष 2009-10 के दौरान संस्थान ने वैज्ञानिक डाटाओं के आधार पर मछली का टिकाऊ विदोहन, समुद्री संवर्धन प्रौद्योगिकियों से उत्पादन बढाने और समुद्री जैववैविद्यता का परिरक्षण करने पर 30 गृहांदर और 30 प्रायोजित और 13 परामर्श परियोजनाएं कार्यान्वित कीं । मुख्यांश नीचे के अनुसार है ।

वर्ष 2009 की आकलित समुद्री मछली पकड 3.16 मिलियन टन के मद्दे मिली पकड पिछले वर्ष 2008 की अपेक्षा 43,891 टन कम थी । कुल अवतरण में 52% पेलाजिक, 28% डमेर्सल, 16% क्रस्टेशियाई और 4% मोलस्काई संपदाएं थीं । सब से अधिक अवतरण पश्चिम तट (56%) से प्राप्त हुआ । सब से अधिक प्राप्त हुई मछली तारली *सार्डिनेल्ला लोंगिसेप्स* थी । कुल पकड में 12.4% के साथ इसका योगदान 3,92,486 टन था। इसके पीछे 8.9% के साथ झींगे आया था जिका योगदान 2,32,313 टन था । 2009 के दौरान भारतीय बाँगडा, शिंगटी और थ्रेडफिन ब्रीम की पकड में बढती हुई जबकि शीर्षपाद की पकड में 20% घटती हुई ।

देश के समुद्रवर्ती राज्यों में वर्ष के दौरान केरल से उच्चतम समुद्री मछली पकड (5,17,591 टन) प्राप्त हुई थी फिर भी यह पिछले वर्ष की तुलना में 22% कम थी । कुल अवतरण का 95% रिंगसीन के ज़रिए हुआ था । केरल की कुल वेलापवर्ती संपदा पकड का 48.6% *सार्डिनेल्ला लोंगिसेप्स* का योगदान था । लक्षद्वीप से वर्ष के दौरान प्राप्त आकलित पकड 10,189 टन था जिसका 81.1% ट्यूना मछली थी और पकड में 4.5% वृद्धि हुई थी । संपदा निर्धारण अध्ययनों ने व्यक्त किया कि *डेकाप्टीरस रसेलि* और *सेलार क्रूमेनोप्थालमस* विदोहन के नीचे के स्तर पर है । केरल से प्राप्त क्रस्टेशियाई संपदाएं झींगों में *मेटापेनिअस डोबसोनि* और केकडों में *कारिब्डिस फेरियाटिस* मुख्य थे। शीर्षपाद अवतरण पिछले वर्ष की तुलना में 45% कम था ।

कर्नाटक के मछली अवतरण में वर्ष 2008 की तुलना में वर्ष के दौरान 15.9% और गोवा के अवतरण में 35.4% की घटती हुई; फिर भी यहाँ बाँगडे, उपास्थिमीन और चिंगट की पकड में वृद्धि की प्रवणता दिखाई पडी । FiSAT के ज़रिए वर्ष 2009 के दौरान चलाए विदोहन स्टाटस ने व्यक्त किया कि अध्ययन किए गए 24 मछली जातियों में से 19 जातियों का विदोहन अनुकूलतम ($E \geq 0.6$) स्तर से ऊपर है ।

वर्ष 2009 के दौरान गुजरात की आकलित वार्षिक पकड सांख्यिकी में 10% बढावा देखा गया । नॉन-पेनिआइड झींगे, सीनेइड, फीतामीन और बंबिल का उच्चतम अवतरण हुआ था । वेरावल में ट्रालरों के ज़रिए 41.9 टन यूनिकोर्न लेथजैक *अलूटेरस मोनोसेरोस* की अच्छी पकड हुई थी । 2009 के दौरान महाराष्ट्र की मात्स्यिकी पकड में 11.9% घटती हुई । महाराष्ट्र के लिए आकलित लंबी अवधि शक्य पकड (LTPY) 5.18 लाख टन के मद्दे प्राप्त वार्षिक औसत (2006-2008) पकड 3.52 लाख टन थी । तलमज्जी, बडी और छोटी वेलापवर्ती की पकड के लिए लंबी अवधि शक्य पकड अध्ययन के अनुसार का अनुकूलतम बेडों की संख्या 8,783 मत्स्यन बोट होने पर भी राज्य में इस पर 23,508 बोट पंजीकृत करते हुए देखा । इन बोटों में मछली संभरण करने की अतिक्षमता होने पर भी पकड कम मिल रही है जो कि मछली अकाल का सूचक है ।

तमिलनाडु की समुद्री मछली पकड में 16.5% की वृद्धि हुई; वर्ष 2009 में 4,81,783 टन की वृद्धि के साथ राज्य ने देश के समुद्रवर्ती राज्यों में तीसरे स्थान पर आया । 2009 के दौरान तुम्बिल, सुरमई, पर्च, थ्रेडफिन ब्रीम मछलियों की पकड में विचारणीय वृद्धि हुई । इस क्षेत्र के खडी जैवमात्रा संपदा में मुख्य मछलियाँ जैसे फीतामीन, थ्रेडफिन ब्रीम, *पेनिअस सेमिसलकाटस* के अंडजनन की गई संपदाएं उच्च मात्रा में देखी गयी । क्रस्टेशिया वर्ग में *पेनिअस सेमिसलकाटस* प्रचुर जाति थी जिसका वार्षिक योगदान 87.1% था । मंडपम से प्राप्त मेटापेनिअस स्ट्रिडुलन्स इसके पीछे आया था । केकडे का योगदान 609 टन था । मुख्य पकड *पोर्टूनस पेलाजिकस* (86.4%) की थी । महाचिंगट (लोब्स्टर) का उत्पादन 274 टन पहूँच गया ।

आंध्रा प्रदेश की मछली पकड पिछले पाँच वर्षों में वर्धित होती जा रही थी और 2009 में 2,83,795 टन के साथ सब से उच्चतम बढती हासिल की । महत्वपूर्ण उपलब्धि वेलापवर्ती वर्ग में हुई 26.3% की वृद्धि थी । वर्ष के दौरान तलमज्जी, क्रस्टेशिया और मोलस्क वर्गों की पकड में पूर्ण रूप से वृद्धि हुई ।

वर्ष 2009 में भारतीय तटों से कुल 61,972 टन ट्यूना मछली का अवतरण हुआ । पकड में *ई.अफिनिस* जाति 46.1%

के साथ प्रथम स्थान पर आयीं, इसके पीछे 22.1% के साथ *टी.अलबाकार्स* और 19.3% के साथ *के. पेलामिस* जातियाँ आयी । सात ट्यूना जातियों का आनुवंशिक मानचित्रण करके NCBI में जमा किया । आनुवंशिक अध्ययन व्यक्त करता है कि तटीय ट्यूना विदोहन उच्चतम वहनीय पकड पर पहूँच गया है जबकि महासागरीय ट्यूनाओं का 75% अब तक अविदोहित है, इन्हें पकडने का श्रम बढाया जाना चहिए ।

वेरावल में देश का सब से अधिक उप पकड मछली (24.7%) पकडी गयी थी । कम मूल्य के होने पर भी 33,337 टन उप पकड मछली जो ट्राल आनायन में प्राप्त हुई का आकलित मूल्य 11.2 करोड रुपए हैं । माँगलूर में पायी गई उप पकड *लागोसेफालस इनेर्मिस* (13.6%) थी । विशाखपट्टणम के ट्राल अवतरण का 9.7% कचडा मछली थी । यह पिछले वर्ष 2008 की तुलना में 65% अधिक है । भारतीय तटों से उप पकड का प्रतिशत कम करने को ट्राल नेट के कॉड एन्ड जालाक्षि का सब से बडा आयाम 35 मि मी करने, तरुण मछलियों को पकडने के उपायों को कम करने और 'तल्लुमाडी' जैसा मिनि ट्रालिंग रोकने का सुझाव दिया गया । टुटिकोरिन में *पी.सेमिसलकाटस* झींगों के तरुणों के विदोहन से हर वर्ष 80 लाख रुपयों का नष्ट आकलित किया गया था ।

समुद्री मछलियों की जैवमात्रा प्रबन्धन पर मान्नार की खाडी में चलाए ट्रोफिक मॉडल अध्ययनों ने व्यक्त किया कि खाडी में देश के उत्तर-पश्चिम तट की तुलना में प्राथमिक उत्पादन, नेट सिस्टम उत्पादन और कुल जैवमात्रा अधिक होते हैं । केरल का बाँगडा अवतरण, प्राथमिक उत्पादकता, तारली पकड, सब सर्फस पानी की ऑक्सिजन मात्रा और टूटिकोरिन के बॉगडा अवतरण के बीच क्लोरोफिल 'सी' का सकारात्मक संबंध साबित किया गया । चुनी गयी पख मछलियों, श्रिंपों, मोलस्कों और केकडों में भारी धातु, आर्सेनिक और मेरकुरी की मात्रा अनुमत्य दर पर देखी गयी । रामेश्वरम और मान्नार की खाडी के पास ड्रेडजिंग के कारण सिलिकेट की मात्रा 6.6 $\mu g\ l^{-1}$ में बढते हुए देखा ।

समुद्री संवर्धन में वर्ष के दौरान सी एम एफ आर आइ ने महत्वपूर्ण उपलब्धियाँ हासिल की। कोबिया के प्रजनन पर किए गए अविरोध दृढ प्रयासों ने कोबिया के सफल अंडजनन में परिणत हुआ । भारत उप भूखंड में कोबिया का ऐसा प्रजनन पहली उपलब्धि है और इस प्रजनन में 2.1 मिलियन अंडे प्राप्त हुए । इसके लिए विषिंजम खाडी में लंगर किए पंजरों में पालित 41 स्वस्थ कोबिया मछलियों को परिवहन करके मंडपम में स्थापित खुले सागर पंजरों में पालन किया था । स्फुटित डिम्भकों की अच्छी बढती हो रही है । विषिंजम में शूली महाचिंगट *पानुलिरस होमारास* और एशियाई सी बास *लाटस कालकारिफर* का खुला समुद्र पंजरा पालन और फसल काट इस वर्ष की महत्वपूर्ण उपलब्धियाँ हैं । मंडपम में जलजीवशाला मछलियाँ *आंफीप्रियोन पर्कुला*, *ए.सीबे*, *क्रिसिप्टीरा सयनिए, पोमासेन्ट्रस केयेरुलस* और *डासिलस अरुआनस* का हैचरी पालन और उत्पादन समुद्री संवर्धन के अंदर के मुख्य कार्यकलाप थे । कोच्ची में *ऑरोफिप्रिओन फ्रेनाटस* के प्रजनन और डिम्भक पालन में सफलता प्राप्त की जो कि भारत में पहली बार है ।

मुक्ता शुक्ति *पिंक्टाडा फ्यूकाटा* के करीब 30,000 पुनर्रोपणयोग्य स्पैटों का हैचरी पालन परंपरागत रीति से करके 1700 स्पैट खेती के लिए दिया गया । मंडपम हैचरी में विकसित किए 14.86 मिलियन ब्लू स्विम्मर केकडा की ज़ोइयों में से, 4130 शिशु कर्कटों का पालन परीक्षण, नाली जल और समुद्री संवर्धन खेत में किया गया । संस्थान के चन्नई, कोवलम फील्ड प्रयोगशाला में नेत्रवृंत अपक्षरण या होर्मोणिकी प्रयोग के बिना किए गए बंधनावस्था पालन में स्पाइनी लॉब्स्टर *पानुलिरस ऑरनेटस* ने परिपक्वता प्राप्त करके प्रजनन किया । लघु पैमाने के मछुआरों द्वारा किए गए द्विकपाटी पालन में 19,882 टन फसल का संग्रहण, मात्र केरल से किया गया । *पाफिया मलबारिका, मेरेट्रिक्स मेरेट्रिक्स, क्रासोस्ट्रिआ माड्रासेनसिस* और *पिंक्टाडा मारगराटिफेरा* के स्पैटों का बडी मात्रा हैचरी उत्पादन संस्थान के विशाखपट्टणम और टूटिकोरिन अनुसंधान केंद्रों में प्राप्त किया ।

कोच्ची में किए जाने वाले खुला समुद्री मछली पालन में मछलियों की खिलावट, पंजरों की सफाई और सुरक्षा कार्य में सामुदायिक सहयोग प्राप्त हुआ । पंजरा पालन लाभकारी तौर पर किए जाने को पंजरों को लंगर करने की विधि और रूप-कल्पना में अनुसंधान चलाए गए । परिरक्षण-माँग की चुनी जातियाँ जैसे *सैप्रेई, चिकोरेस* जातियाँ और *लांबिस लांबिस* के समुद्री संवर्धन करने के परीक्षण किए गए ।

दक्षिण-पश्चिम तट में प्रवालों की विपुलता और जैव वैविद्यता समझने के लिए किए गए जलांदर सर्वेक्षणों ने प्रवालों की विषम बढती और कम वितरण दिखाया दिया । हार्ड कोरल अथवा कठोर प्रवाल में 'पिंक लाइन सिन्ड्रोम' और 'पोरैटस अलसरेटिव वाइट स्पाट सिन्ड्रोम' दिखाए पडे। मिनि ट्राल अथवा 'तल्लुमाडी' के प्रचालन से तिरुपिलाकुडी और देवीपट्नम क्षेत्रों और

गिल नेट (नंदु वलै) प्रचालन से मंडपम के स्पंज संपदाओं का भारी नष्ट होने की रिपोर्ट प्राप्त हुई । मुख्यालय कोच्ची की हैचरी में लोबोफैटम और सिनूलिरिया वंश के जीवंत मृदु प्रवालों का अनुरक्षण और फ्रागमेन्टेशन तकनीक से इनके प्रवर्धन करने का परीक्षण चल रहा है ।

पाम्बन द्वीप में समुद्री ककडी होलोथूरिया अट्रा की सांख्यिकीय सघनता पर किए अध्ययन ने व्यक्त किया कि 1.53 और 1.8 g/m^2 जैवमात्रा परास के बीच यह 0.01से 0.02 $no./m^2$ के बीच बदलती रहती है । चुने गए अवतरण केंद्रों से लुटजानिडे कुटुम्ब की कुल 31 मछली जातियों का संग्रहण किया गया। आप्रियोन (Aprion), एटिलस (Etelis), लिपोचीलियस (Lipocheilus), पारासीसियो (Paracaesio) और पिंजलो (Pinjalo) मोनोटिपिक वंश है । मान्नार की खाडी और पाक की खाडी में किए सर्वेक्षणों में माइक्रो आलगे की 87 जातियों का समाहरण किया गया । सभी जातियों का वनस्पति-संग्रहालय तैयार किया गया। समुद्री शैवालों के रंग परिरक्षित करके रखने की कोशिश की गयी । वर्ष के दौरान सी एम एफ आर आइ द्वारा विकसित किया उत्पाद कडलमीन™ वर्णा अलंकार मछली खाद्य का मानकीकरण किया गया । दूसरा महत्वपूर्ण उत्पाद हरित शंबु से विकसित किया मसल एक्स्ट्राक्ट 'कडलमीन™ GMe' था जो भेषजीय गुणों से युक्त है ।

टूटिकोरिन तटों के शुक्ति संस्तर (*पिंक्टाडा फ्यूकाटा*) की प्राकृतिक अवनति का कारण *पेर्किन्सस ओलसेनि* नामक एककोशीय सूक्ष्मजीव परजीवी दिखाया पडा । समुद्री रेड स्नाप्पर *लूटजानस अर्जेन्टिमाकुलाटस* के आंत्र में मिक्सोस्पोरियन और गोल ब्लाडर में एकान्थोसेफालन रोगबाधा पहचाना गया । *एपिनेफेलस मलबारिकस* से विकसित किए पाँच सेल कल्चर पद्धति से दो (गिल एक्सप्लान्ट से विकसित Em3GEX व स्प्लीन एक्सप्लान्ट से विकसित E. M4SpEx) ने 100 पासेजस पार किया। CO-1 जीन का PCR आंप्लिफिकेशन और अनुवर्ती सीक्वेंसिंग से दो ट्यूना जातियाँ *सारडा ओरियेंटालिस* और *थन्नस डोंगोल* का बारकोडिंग किया गया. इसी तकनीक से *पिंक्टाडा फ्यूकाटा, क्रासोस्ट्रिया माड्रासेनसिस* और *पेर्ना इंडिका* के तनाव सह्यता और रोग प्रतिरोधता संबंधी जीनोमी अध्ययन चलाया गया ।

मछली पकड में बहु दिवसीय मत्स्यन ट्रॉलिंग सबसे उत्पादकीय देखा गया। निर्यात मार्केट में शीतीकृत श्रिंप का व्यापार सबसे अधिक हुआ था जिस से कुल निर्यात आय का 44% प्राप्त हुआ। जलवायु परिवर्तन संबंधी अध्ययनों ने व्यक्त किया कि तटीय उत्स्रवण सूचक और मानसून के दौरान Chl *a* की उपस्थिति ने मानसूनोत्तर अवधि में तारली की पकड को बढ़ाई है। गहरा सागर सर्वेक्षणों ने 36 से अधिक गहरा सागर सुरा जातियों के बारे में रिपोर्ट की । सी एम एफ आर आइ द्वारा एक नूतन कार्यक्रम 'फिश वाच 'शुरू किया जिस में मुख्य मछलियों का अवतरणवार विवरण और मूल्य दिखया गया है। भारतीय कृषि अनुसंधान परिषद का 'हरितोत्सवम 2009 ' का आयोजन संस्थान में किया गया ! समुद्री स्तनपाईयों के परिरक्षण और अनुसंधान के भाग के रूप में समुद्री स्तनपाइयों के धँसन पर नैशनल ओशियानिक एंड अटमोस्फेरिक अड्मिनिस्ट्रेशन (NOAA) के सहयोग से जनवरी 2010 में संस्थान ने एक अंतर्राष्ट्रीय कार्यशाला आयोजित की जिस में 42 भागीदार भाग लिए.

वर्ष के दौरान सी एम एफ आर आइ ने समुद्री मात्स्यिकी, जैवप्रौद्योगिकी, समुद्री संवर्धन और संबंधित क्षेत्रों में दो किताब, 66 अनुसंधान लेख, दो ऑनलाइन जर्नल, 26 तकनीकी लेख, 28 लोकप्रिय लेख और तीन बुक चाप्टेर्स प्रकाशित किए। राजभाषा हिंदी के उत्तम निष्पादन केलिए संस्थान ने परिषद द्वारा स्थापित राजर्षि टंडन अवार्ड और कोच्ची नगर राजभाषा कार्यान्वयन समिति का राजभाषा रोलिंग ट्रोफी हासिल की। मानव संपदा विकास कक्ष ने विविध विषयों पर 11 प्रशिक्षण कार्यक्रम आयोजित किए। कृषि विज्ञान केंद्र , नारक्कल ने कृषि में 14 और गृहविज्ञान में 16 पाठ्यक्रमों से 46 प्रशिक्षण कार्यक्रम आयोजित किए जिससे 1,086 ग्रामीण लोग लाभ उठाए।

वर्ष के दौरान संस्थाने ने निजी और सार्वजनिक सेक्टरों केलिए 179 लाख रुपयों की 13 परामर्श परियोजनायें कार्यान्वित कीं। संस्थान के वैज्ञानिकों द्वारा अब बाहरी निधिबद्ध 30 परियोजनाओं का कार्यान्वयन किया जा रहा है जिनमें पाँच नैशनल अग्रिकल्चर इन्नोवेटीव प्रोजक्ट (NAIP) का बहुशाखीय और बहु संस्थानीय वाल्यू चेइन परियोजनाएं हैं। इन परियोजनाओं का कुल मूल्य 1794.077 लाख रुपए हैं। मात्स्यिकी को आगे बढ़ाने के महत्वपूर्ण विषय जैसे समुद्री पख मछली और कवच मछली उत्पादन पर सी एम एफ आर आइ के वैज्ञानिकों को अन्य मंत्रालयों और अभिकरणों से परियोजनाएं प्राप्त हुई है । संस्थान से 9 पेटेंट इस संबंधी अनुमति केलिए क्षेत्रीय पेटेंट कार्यालय को दे दी गई है!

EXECUTIVE SUMMARY

During the year 2009-10, CMFRI achieved the targets earmarked for 30 in-house, 30 sponsored and 13 consultancy projects which focused on addressing the issues related to sustainable exploitation of fishery resources from the wild based on real time scientific data, production through mariculture technologies and conservation of marine biodiversity. The salient outputs are as designated below:

The marine fish landings of India for the year 2009 have been estimated provisionally at 3.16 million tonnes which showed a decline of around 43, 891 t compared to the previous year. Pelagic finfishes contributed 52%, demersal 28%, crustaceans 16% and molluscs 4% of the total landings. The mechanized sector yielded 74%, motorized 22% and artisanal 4% of the catches along the coastline. Landings were more from the west coast (56%). The oil sardine *Sardinella longiceps* continued to be the largest contributor to the marine fish resources during this year also accounting for 3, 92,486 t (12.4%) followed by penaeid shrimps 2, 32,313 t (8.9%). Indian mackerel, catfish and threadfin breams registered increased catches during 2009 while cephalopods suffered a setback by 20%.

Marine fish resources caught along Kerala coast topped (5,17,591 t) the list among the maritime states of India but showed a decrease of 22% compared to the year 2008. Ring seine landed 95% of the total landings. The major component, *Sardinella longiceps* contributed 48.6% of the total pelagic resources of Kerala. In Lakshadweep 81.1% of the estimated landings (10,189 t) was constituted by tunas with an increase of 4.5% during the year.

Stock assessment studies revealed that both *Decapterus russelli* and *Selar crumenophthalmus* remain under-exploited at present. *Metapenaeus dobsoni* in penaeid shrimps and *Charybdis feriatus* in crabs were the mainstay of crustacean fishery in Kerala. The cephalopod landings showed a drastic reduction of around 45% compared to last year. Rapid appraisal efforts are being made through Multi Dimensional Scaling approach with specific focus on fisheries of small pelagics and crustaceans off Kerala coast on the multiple factors which will lead to sustainability.

The total marine fish landings (2, 77,553 t) of Karnataka were also on the decline by 15.9% and Goa by 35.4% compared to 2008 though the mackerels, elasmobranchs and shrimps showed an increasing trend. Status of exploitation by *FiSAT* based catch curve method revealed that out of 24 species studied, 19 species were exploited above optimum ($E \geq 0.6$) level in 2009.

The estimated annual catch statistics of Gujarat showed an improvement of 10% during 2009. Maximum landing was noticed in non-penaeid prawns, sciaenids, ribbonfishes and Bombayduck. Emergence of a new fishery for the unicorn leatherjacket *Aluterus monoceros* was noticed from trawlers (41.9 t) at Veraval.The marine fish landing of Maharashtra during 2009 was 3.16 lakh t showing a reduction of 11.9%. LTPY estimated for Maharashtra was 5.18 lakh t against the annual average (2006-2008) catch of 3.52 lakh t. Based on LTPY studies for demersal, large and small pelagics, the optimum fleet size arrived at is only 8,783 fishing boats as against the present fleet size of 23,508 boats registered in the state. The analysis forebodes gross overcapacity in the fishing fleet and a grim warning for the advent of fish famine at individual boat level due to poor catch rate.

Tamil Nadu showed 16.5% increase in catch totalling to 4,81,783 t in 2009 and contributed 15.2% to the all-India estimates, standing third in marine resources. Lizardfish, seerfish, perches and threadfin breams registered remarkable increase in 2009. VPA analyses show a high percentage of spawning stock in the standing stock biomass of many important fishes like ribbonfishes and threadfin breams. *Penaeus semisulcatus* was the dominant species among crustaceans throughout the year with annual composition of 87.1% followed by *Metapenaeus*

stridulans at Mandapam. The landing of crabs was 609 t supported mainly by *Portunus pelagicus* (86.4%). Lobster production reached 274 t. The marine fish landings along Andhra Pradesh coast showed a significant expansion during the past five years to register an all time high catch of 2,83,795 t in 2009. The significant feature was the 26.3% rise in the landings of pelagic fishes. An overall increase in demersal fishes, crustaceans and molluscs was also observed during the year.

The tuna landings along the Indian coast were estimated at 61,972 t during 2009. *E. affinis* dominated (46.1%) the catch, followed by *T. albacares* (22.1%) and *K. pelamis* (9.3%). Genetic barcoding of seven species was done and deposited in NCBI. Stock assessment shows that the coastal tuna is exploited very close to MSY level but the oceanic tuna potential is currently more than 75% unexplored, giving scope for considerable enhancement and expansion in terms of capture.

The highest quantity (33,337 t) of low value bycatch (LVB) was landed at Veraval, forming 24.7% of total trawl landings and the value realized was at Rs. 11.2 crores. *Lagocephalus inermis* (13.6%) was the major contributor to the trash at Mangalore. LVB formed 9.7% of total trawl landings with an increase of 65% compared to 2008 in Visakhapatnam. Increasing the cod-end mesh size of trawl nets to 35 mm, usage of bycatch reduction devices and prohibition of minitrawling like *thallumadi* in coastal nursery areas are the rapid remedial measures advocated to overcome LVB and save the resources from wanton destruction along the Indian coasts. The economic loss to the fishermen by exploiting the juvenile shrimps of *P. semisulcatus* was estimated at Rs. 80 lakhs/year at Tuticorin.

The trophic model mass balanced and fitted for marine fisheries management in Gulf of Mannar signified that the net primary production, net system production and total biomass are much higher in GoM compared to northwest coast of India. Positive correlation was evident between chlorophyll *c* concentration and mackerel landing in Kerala, primary productivity and sardine catches, dissolved oxygen content of subsurface waters and mackerel landing at Tuticorin. Heavy metals, arsenic and mercury in selected finfishes, shrimps, molluscs and crabs are found to be within the permissible levels. An area which requires urgent action is the rising silicate content as high as 6.6 $\mu g\ l^{-1}$ due to dredging near Rameswaram and Gulf of Mannar.

CMFRI has made remarkable achievement in the field of mariculture during the year. The consistent and persevering efforts in cobia breeding manifested in the production of 2.1 million eggs for the first time in the Indian subcontinent opening a new chapter for economically valuable marine fish seed production and farming. Broodstock of 41 healthy cobia fishes reared in cages attached to the raft moored in Vizhinjam Bay were transported and stocked in open sea cages off Mandapam. The newly hatched larvae are progressing well under controlled conditions**.** Successful harvests of spiny lobster (*Panulirus homarus)* and Asian seabass (*Lates calcarifer*) from open sea cages at Vizhinjam coast are among the notable milestones of the year. Our accomplishments in ornamental fish culture include scaling-up of hatchery production of *Amphiprion percula, A. sebae, Chrysiptera cyanea, Pomacentrus caeruleus* and *Dascyllus aruanus* at Mandapam. Breeding and larval rearing of *Amphiprion frenatus* was realized for the first time in India at Cochin.

About 30,000 numbers of transplantable spats of pearl oyster *Pinctada fucata* were grown in the hatchery under conventional rearing method and 1700 hatchery raised spats were supplied for farming. Among the 14.86 million blue swimmer crab zoeae produced in hatchery experiments at Mandapam, 4130 baby crabs were used in farming experiments in raceway and mariculture farm. Maturation and breeding of the ornate spiny lobster *Panulirus ornatus* in captivity without eye ablation or hormonal administration was accomplished for the first time at Kovalam Field Laboratory of CMFRI, at Chennai. The farmed bivalve production by small scale commercial farms reached new heights and recorded 19882 t during the year in Kerala alone. Large scale spat production of *Paphia malabarica, Meretrix meretrix, Crassostrea madrasensis* and *Pinctada margaritifera* was achieved in the marine hatcheries of Visakhapatnam Regional Centre and Tuticorin Research Centre.

Community involvement of the fishers at Cochin, where the cages are being managed by feeding, cleaning the fouling organisms and providing security is a highly noteworthy feature. Innovations in cage mooring system and cage design are experimented by CMFRI to realize good return through cage farming. Mariculture of selected species of conservation importance like *Cypraea, Chicoreus* spp. and *Lambis lambis* are also attempted.

The underwater surveys conducted along the south-west coast to assess the status of coral cover and biodiversity showed the coral growth patchy and sparsely distributed. 'Pink Line Syndrome' and '*Porites* Ulcerative White Spot Syndrome' were found prevalent among the hard corals. Studies conducted at Thiruppalaikudi and Devipatnam areas revealed severe damage to the sponge resources caused by mini-trawl (*Thallumadi*) and bottom set gillnet (*Nandu valai*) operations off Mandapam. Live colonies of soft coral species belonging to the genera *Lobophytum* and *Sinularia* were maintained in the hatchery at the Headquarters for culture experiments through fragmentation technique. *Lobophytum crassum* fragments got attached to the substrata provided and showed growth from the base.

The numerical density of sea cucumber *Holothuria atra* at Pamban Island varied from 0.01 to 0.02 no. m^{-2} with a biomass ranging between 1.53 and 1.8 g m^{-2}. Investigations on family Lutjanidae revealed 31 species with 5 monotypic genera of *Aprion, Etelis, Lipocheilus, Paracaesio* and *Pinjalo*. Altogether 87 species of macroalgae were collected during surveys conducted in Gulf of Mannar and Palk Bay. Herbarium of all the species have been prepared and colour preservation of the seaweeds also attempted.

The 'Cadalmin™ *Varna'* series of ornamental fish feeds standardised and refined in terms of packaging and colouring with natural colour sources was yet another striking performance in product development by CMFRI. In the marine bioprospecting area, the development of another significantly remarkable product, the green mussel extract 'Cadalmin™ GMe' is designed to find a unique way to shelf-life stability and anti-inflammatory principles.

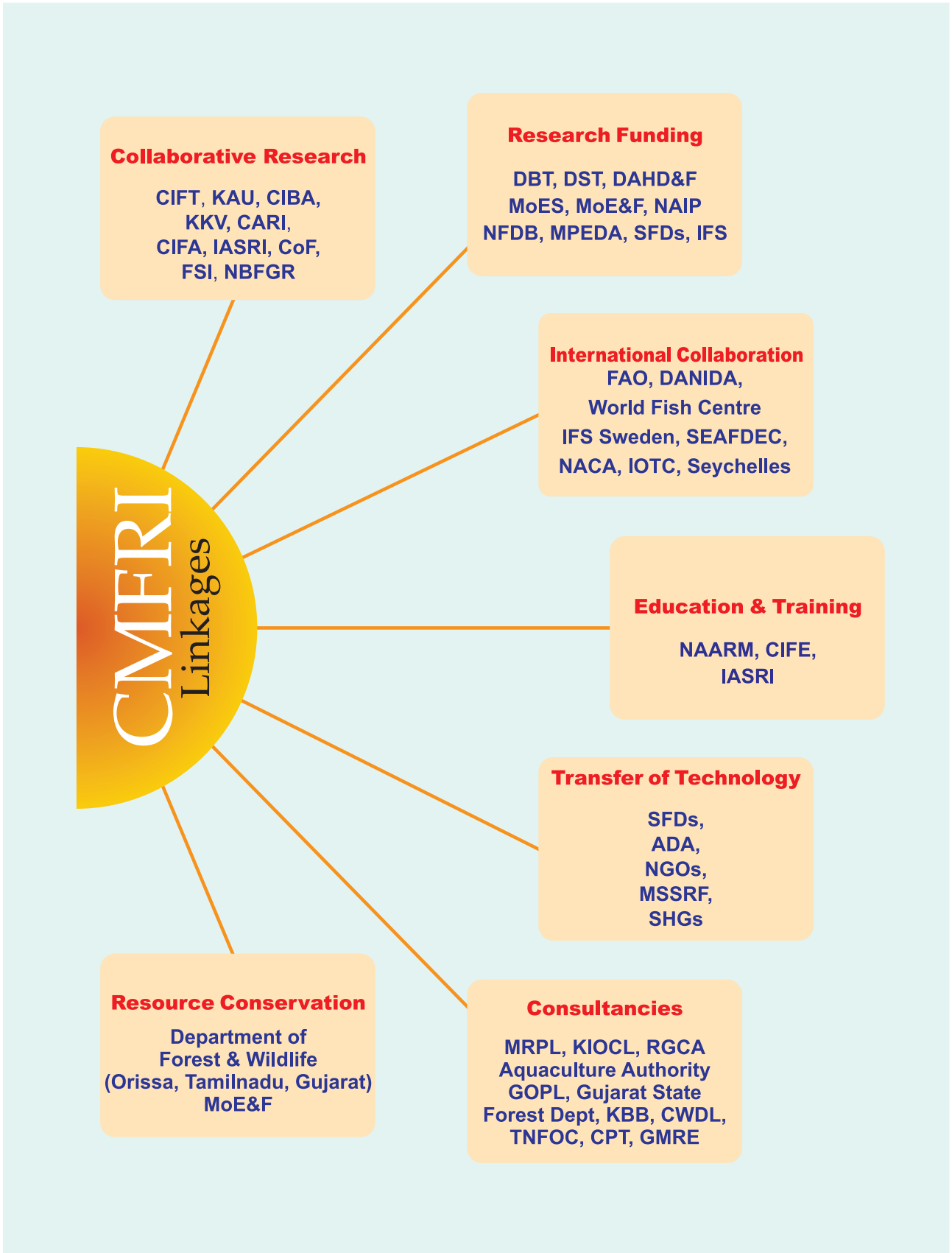
Perkinsus olseni, an OIE listed protozoan parasite with a prevalence of 100% was found to be one of the major reasons for the decline of the natural pearl oyster beds (*Pinctada fucata*) along the Tuticorin coast. High levels of acanthocephalan infection in the intestine and myxosporean infection in the gall bladder were recorded in the wild red snapper *Lutjanus argentimaculatus*.

Out of the five cell culture systems developed from *Epinephelus malabaricus*, two (Em3GEX from gill explants and E. M4SpEx from spleen explants) have crossed 100 passages. Bar coding of two species of tunas namely *Sarda orientalis* and *Thunnus tonggol* was carried out through PCR amplification of CO-1 gene followed by sequencing. Characterization of the functional genes involved in stress tolerance and disease resistance of *Pinctada fucata*, *Crassostrea madrasensis* and *Perna indica* was carried out through PCR amplification of CO-1 gene followed by sequencing.

The capital productivity was observed to be the most efficient in the MDF trawling (>6 days) at Versova with the lowest operating ratio of 0.55. Frozen shrimp continued to be the single largest item of export in terms of value accounting for about 44% in the total export earnings. Investigations related to climate change signified that the increasing Coastal Upwelling Index and the prevailing high concentration of Chl *a* during monsoon sustained an increased catch of oil sardine during post-monsoon season. More than 36 species of deepsea sharks were recorded during the deepsea surveys. CMFRI launched an innovative programme 'Fish Watch'. National seminar on enhancing agricultural productivity and profitability of ICAR institutes was organized in CMFRI. An international workshop involving 42 participants on Marine Mammal Stranding in collaboration with NOAA was the highlight of January 2010 focusing mainly on marine mammal research as well as conservation and initiating steps for formation of a network in future.

CMFRI published two books, 66 research papers in peer reviewed journals, two in online journals, 26 technical articles, 28 popular articles and three book chapters on important aspects of marine fisheries, biotechnology, mariculture and related fields. Rajarshi Tandon Award and Rajbhasha Rolling Trophy were bagged by CMFRI for the excellent performance in Official Language Implementation. HRD Cell conducted 11 training programmes on various disciplines and Krishi Vigyan Kendra, Narakkal organized 46 training courses for 1,086 villagers, 14 courses in Agriculture and 16 courses in Home Science.

CMFRI is executing 13 consultancies for the private and public sector worth Rs. 179 lakhs. Scientists of this institute are currently implementing 30 externally funded projects inclusive of five multi-disciplinary and multi-institutional value chain projects under NAIP, worth Rs. 1794.077 lakhs. Projects on marine finfish and shellfish production and major thrust areas of immediate concern in fisheries are awarded to CMFRI scientists from agencies like MoES, MoA, DBT, DST, NFDB, TNFD, INCOIS, ICAR Network and MPEDA. Nine patents have been submitted from CMFRI Intellectual Property Management and Technology Transfer/ Commercialization Unit to the regional patent office.


CMFRI
Linkages
Collaborative Research
CIFT, KAU, CIBA,
KKV, CARI,
CIFA, IASRI, CoF,
FSI, NBFGR
Research Funding
DBT, DST, DAHD&F
MoES, MoE&F, NAIP
NFDB, MPEDA, SFDs, IFS
International Collaboration
FAO, DANIDA,
World Fish Centre
IFS Sweden, SEAFDEC,
NACA, IOTC, Seychelles
Education & Training
NAARM, CIFE,
IASRI
Transfer of Technology
SFDs,
ADA,
NGOs,
MSSRF,
SHGs
Resource Conservation
Department of
Forest & Wildlife
(Orissa, Tamilnadu, Gujarat)
MoE&F
Consultancies
MRPL, KIOCL, RGCA
Aquaculture Authority
GOPL, Gujarat State
Forest Dept, KBB, CWDL,
TNFOC, CPT, GMRE

INTRODUCTION

As the premier Marine Fisheries Research Institute in India with its 62 years of dedicated service to the nation in the marine fisheries sector, the Central Marine Fisheries Research Institute persevered incessantly to find ways and means to sustain the potential source of food in capture and culture fisheries. Our efforts were focused to supplement and enhance the natural stocks through ecofriendly mechanisms such as capture-based aquaculture (CBA) of selected commercially important species, fish aggregating devices (FADs), appropriate strategies for sustainable management and conservation of marine biodiversity of the EEZ encompassing a holistic approach to derive maximum returns from the ecosystem and strengthen the food security concerns of India.

The estimated marine fish landings during 2009 was at 3.16 million tonnes, which showed a decline of 43, 891 t when compared to that of the previous year. The west coast remained more productive (56%) than the east coast (44%). Pelagic resources continued to be the principal component of the fisheries. The total catch of oceanic tunas from three islands, Androth, Agatti and Minicoy of the Lakshadweep Sea estimated under the NAIP project – a government-private enterprise joint venture - was 3994 t of which the yellowfin tuna *Thunnus albacares* constituted 16%.

Open sea cage farming of high value finfishes and shellfishes involving the fisherfolk has become the icon of CMFRI to supplement food security potential from the sea. It is also viewed as an opportunity to utilize the existing water resources optimally with high economic returns which in turn would promote poverty alleviation and employment generation. The cage farming technologies are being standardised and refined to suit the rough weather conditions during different seasons in the Indian seas. Open sea cage farming has been quite successful all along the coasts of India and has found favour with the fisherfolk as a means of livelihood and extra income from various bioresources (seabass, ornamental fishes, spiny lobsters, prawns). Development of research infrastructure and techniques catering to the arising issues and application in the diversification of mariculture activities such as pearl production, culture of mussels and commercially important gastropods were the hallmarks of the Institute. CMFRI has successfully demonstrated the breeding of cobia (*Rachycentron canadum*) for the first time in India and the attainment of self sufficiency in marine finfish seed production for culture practices will not be far off. Culture of soft corals and sponges through fragmentation techniques in the hatchery with the wider perspective of transplanting back into the sea is yet another venture initiated during the year.

Our concerted and persevering efforts in product development were also realized during the year by developing a holistic health solution from nature, namely 'Green Mussel Extract (GMe)' and the ornamental fish feed 'Varna'. These products are in great demand and marketed under the trademark of CMFRI 'Cadalmin™'. All our endeavours marked by the highly competent scientific and technical manpower of this Institute empowered with a vision to bring out the best are in tune with the multidisciplinary involvement, which materialises in the form of desired results.

CMFRI launched a new system of filed information dissemination 'Fish Watch' on a near real time basis and a portal signifying 50 years of time-series data on marine fish landings and effort from the year 1954. This unique collation of first hand data displays daily landings of five major groups of fish from six important mechanised landing centres of India and has its base on the well acclaimed sampling design developed by CMFRI. 'Fish Watch' will be a useful tool for policy makers and planners in future.

The Institute monitors regularly the marine fish landings all along the country's coastline, conducts investigations on the impacts of fishing and other human interventions on the natural stocks and marine ecosystems, develops hatchery production systems and sea farming techniques to augment and strengthen the exploited resources, undertakes research on the environmental characteristics, trends and traits of vulnerable biota and habitats coupled with marine biodiversity to conserve the resources and build up a dependable database. Simultaneously, data archaeology, socio-economic costs and benefits, technological feasibilities and participatory approach in co-management of the resources are also critically studied, evaluated and incorporated to imbibe and accomplish the mandatory principles of CMFRI.

Bioassay of guided purification of selected brown and red seaweeds from Gulf of Mannar has resulted in production of antioxidants which are proved to be better than the well-known synthetic antioxidants. Molecular genetic characterisation and functional genomics carried out in the marine bivalves such as *Perna indica, Crassostrea madrasensis* and *Pinctada fucata*, naupliar size reduction achieved from 491 µ to 470 µ in indigenous *Artemia* strains through selective breeding of successive generations, apart from other supplementary research activities in biotechnological field aid in forming a strong base for mariculture in CMFRI.

The Mandate

- *To undertake basic, strategic and applied research in marine fisheries and mariculture.*
- *To monitor and assess the fisheries resources of the Exclusive Economic Zone (EEZ) and to understand the stock and its dynamics in relation to environment and human interventions.*
- *To develop and commercialize hatchery and production system technologies for finfish, shellfish and other commercial marine organisms in coastal and open seas.*
- *To build up database on marine biodiversity, carry out research on fragile marine ecosystems for their conservation and restoration.*
- *To undertake research on utilization of potentially beneficial marine organisms.*
- *To act as a repository of information on marine fishery resources with a systematic and analytical database for policy interventions and to carry out research on social and economic costs and benefits of marine fisheries.*
- *To conduct front line demonstrations and training to develop human resource for R &D in capture fisheries and mariculture.*
- *To create awareness and provide training and consultancy services.*

The Institute has established Regional Centres at Mandapam Camp, Visakhapatnam and Veraval; Research Centres at Mumbai, Karwar, Mangalore, Kozhikode, Vizhinjam, Tuticorin and Chennai and 15 Field Centres to investigate and accomplish the tasks of research and development along the Indian coastline. The entire activity is coordinated by the Headquarters at Cochin. The Institute has built up laboratories, hatcheries and farming facilities for carrying out research programmes over the years and is in the process of upgrading the same to meet the challenging needs and additional requirements.

The multidisciplinary research activities in capture and culture fisheries are conducted under ten Divisions: Fisheries Resources Assessment, Pelagic Fisheries, Demersal Fisheries,

Crustacean Fisheries, Molluscan Fisheries, Fishery Environment Management, Marine Biotechnology, Socio-Economic Evaluation and Technology Transfer, Mariculture and Marine Biodiversity. Inter-divisional and inter-institutional programmes are carried out for greater utilization of expertise and facilities. CMFRI also takes up short-term research projects on important subjects and prioritize through *ad-hoc* research schemes funded by outside agencies in the country and abroad, besides offering consultancy services to the clients from Government organisations and private industries.

CMFRI provides facilities for Ph. D. programmes of the Central Institute of Fisheries Education, Mumbai, and several other Universities in the country. The Library and Documentation Section provides online documentary service on current and vital fishery issues from time to time inclusive of e-prints to research staff and students of CMFRI, besides extending reference facilities to visiting scientists from within and outside the country.

The Krishi Vigyan Kendra of CMFRI**,** Narakkal imparts training in fisheries, mariculture, agriculture, home science, animal husbandry and other related subjects to fish farmers, agricultural farmers and farm women. OFTP in polyculture of finfish and crabs, FLDP of high yielding paddy, plants and trees. Farmers' Field School and mass media programmes have been successfully conducted under the patronage of KVK.

The Official Language Implementation of Hindi carried out by the Official Language Implementation Committee (OLIC) of the Institute does commendable service by conducting seminars, workshops and activities of topical interest. The Hindi section won a number of awrds during the year.

The results of research carried out in the Institute are published in various peer reviewed journals in India and abroad. Besides, the Institute brings out *Bulletins*, *Special Publications*, Quarterly Newsletter and the *Marine Fisheries Information Service* and also publishes the *Indian Journal of Fisheries*.

Staff Strength and Managerial Positions as on 31.03.2010

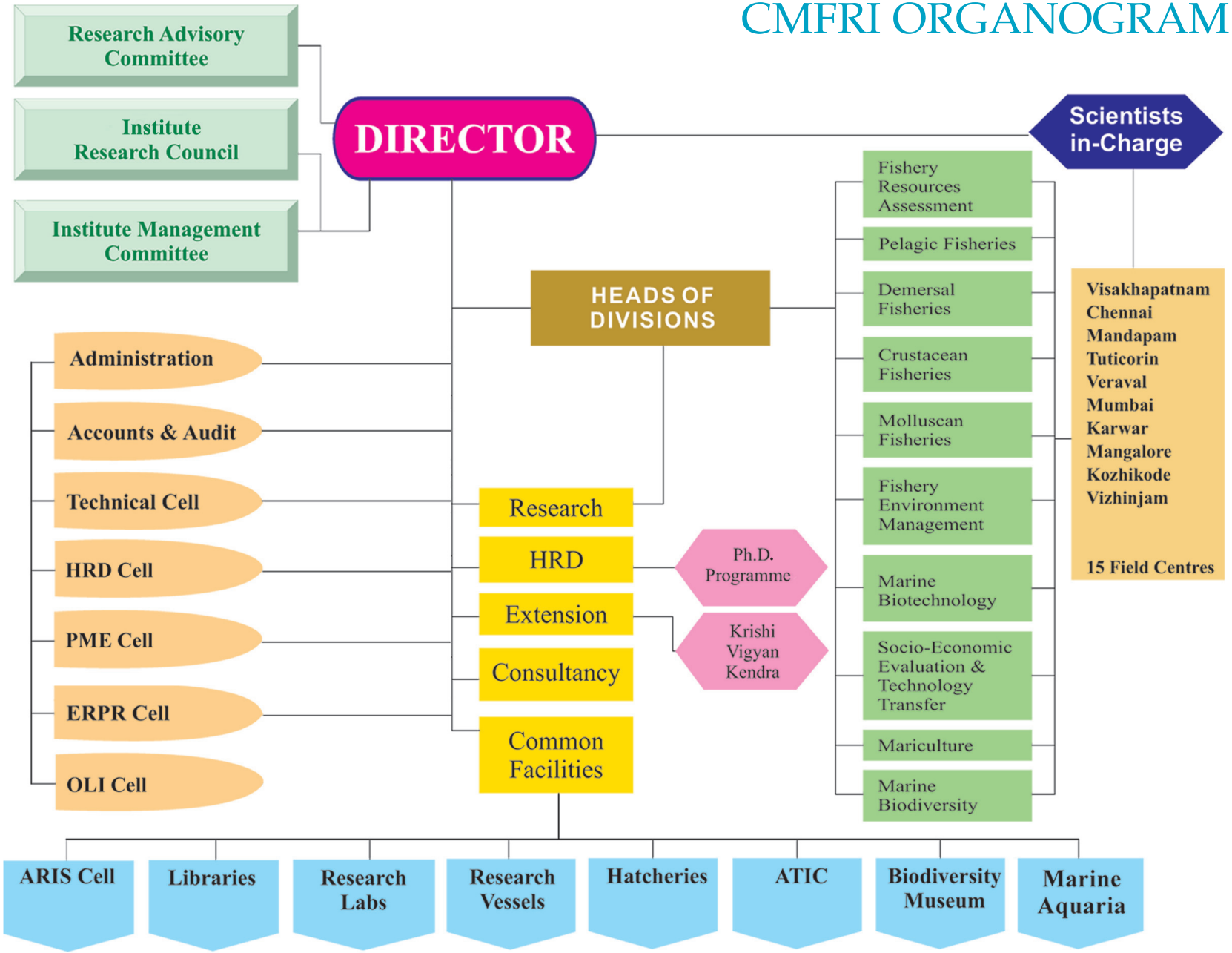
Staff Strength as on 31st March 2010 including KVK, Narakkal

Category	Sanctioned	Staff Filled in	Vacant
RMP	1	1	-
Scientific	173	102	71
Technical	313	272	41
Administrative	149	134	15
Supporting	240	191	49
Auxiliary	4	3	1
Total	**880**	**703**	**177**

Managerial Positions

Director	**Dr. G. Syda Rao**
Heads of Divisions	
Fishery Resources Assessment Division	Dr. E. Vivekanandan
Pelagic Fisheries Division	Dr. N. Gopalakrishna Pillai
Demersal Fisheries Division	Dr. E. Vivekanandan
Crustacean Fisheries Division	Dr. E.V. Radhakrishnan
Molluscan Fisheries Division	Dr. K. Sunilkumar Mohamed
Fishery Environment Management Division	Dr. V. Kripa
Marine Biotechnology Division	Dr. K.K. Vijayan
Socio-Economic Evaluation and Technology Transfer Division	Dr. R. Sathiadhas
Marine Biodiversity Division	Dr. Mary K. Manisseri
Mariculture Division	Dr. G. Gopakumar
Sr. Administrative Officer	Smt. Roja Sethumadhavan
Sr. Finance and Accounts Officer	Shri. A.V. Joseph
Scientists-in-Charge of Regional/Research Centres	
Mandapam Camp	Dr. G. Gopakumar
Chennai	Dr. G. Mohanraj
Tuticorin	Dr. M.S. Madan
Karwar	Dr. K.K. Philippose
Mangalore	Dr. A.P. Dinesh Babu
Veraval	Dr. Gulshad Mohammed
Vizhinjam	Dr. Rani Mary George
Mumbai	Dr. V.D. Deshmukh
Visakhapatnam	Dr. G. Maheswarudu
Calicut	Dr. K. Manmadhan Nair
Krishi Vigyan Kendra, Narakkal	Dr. Asokakumaran Unnithan

CMFRI ORGANOGRAM



Budget 2009 – 2010

The Budget and Expenditure under Non-Plan and Plan for the financial year 2009-2010 in respect of CMFRI (Figures in lakhs)

Budget head	Non-plan		Plan	
	Budget (Rs.)	Expenditure (Rs.)	Budget (Rs.)	Expenditure (Rs.)
Estt. Charges	3490.23	3490.23	0.00	0.00
Wages	0.00	0.00	0.00	0.00
OTA	0.19	0.19	0.00	0.00
TA	17.11	17.11	35.00	35.00
Other Charges	251.27	251.27	513.83	513.83
Information Technology			23.67	23.67
Works	45.16	45.16	175.00	175.00
Other items including HRD	0.00	0.00	2.50	2.50
TOTAL	3803.96	3803.96	750.00	750.00

Pension

Budget head	Budget (Rs.)	Expenditure (Rs.)
Pension	2509.44	2509.44

Loans and Advances

Budget head	Budget (Rs.)	Expenditure (Rs.)
Loans & Advances	14.84	14.84

Other Projects

Budget head	Budget (Rs.)	Expenditure (Rs.)
Other non plan schemes	---	---
NAIP	---	469.15
Other plan schemes		30.65
Deposit schemes	---	221.71
A.P. Cess schemes	---	1.28
KVK, Narakkal		65.50
Consultancies	---	27.98
Heads	**Target (Rs.)**	**Achievements (Rs.)**
Revenue receipts	59.58	67.01
Sale of assets	---	16.67
Interest on short term deposits	20.00	22.08
Recovery of loans and advances	55.00	53.77

Trademark - Cadalmin

The Central Marine Fisheries Research Institute (CMFRI) has officially registered a trademark entitled 'CADALMIN' for the products and services of the institute. The formal inauguration of the trademark was accomplished by Dr. C.D. Mayee, Chairman, Agricultural Scientists Recruitment Board (ASRB) by launching the logo of the trademark on 19.11.09 at CMFRI, Kochi.

Shri Anwar Hashim, National President of the Seafood Exporters Association of India was the guest of honour in the function.

Products:

- Green Mussel Extract (GMe)
- Varna Marine Ornamental Fish Feed
- Sylo feed
- Cobia seed
- Marine Ornamental Fish Seed

List of Projects

In-house projects

Sl. No.	Project Code	Name of the Project	Name of PI	Duration
Marine Capture Fisheries				
1.	FRA/ASSESS/01	Development of knowledge based information system for marine fisheries sustainability	Dr. T.V. Sathianandan	2007 - 2012
2.	FRA/ASSESS/02	Decision support system for marine fisheries management	Dr. J. Jayasankar	2007 - 2012
3.	FRAD/IDP/01	Sustainability profiling of Kerala coast using multi dimensional scaling approach	Dr. J. Jayasankar	2008 - 2010
4.	PEL/IDP/01	Management advisories for sustaining marine fisheries of Kerala and Lakshadweep	Dr. M. Sivadas	2007 - 2012
5.	PEL/IDP/02	Management advisories for sustaining marine fisheries for Karnataka and Goa	Dr. A.P. Dinesh Babu	2007 - 2012
6.	CF/IDP/01	Management advisories for sustaining marine fisheries of Maharashtra	Dr. V.D. Deshmukh	2007 - 2012
7.	DEM/IDP/02	Management advisories for sustaining marine fisheries of Gujarat	Dr. Subhadeep Ghosh	2007 - 2012
8.	DEM/IDP/01	Management advisories for sustaining marine fisheries of Tamil Nadu and Pudicherry	Dr. P.U. Zacharia	2007 - 2012
9.	MF/IDP/01	Developing management advisories for sustaining marine fisheries of Andhra Pradesh	Dr. Prathibha Rohit	2007 - 2012
10.	PEL/IDP/03	Strategies for sustaining tuna fishery along the Indian coast	Dr. E.M. Abdussamed	2008 - 2012
11.	CF/RE/03	Dynamics of recruitment process of penaeid prawns along the Indian coast	Dr. V.D. Deshmukh	2007 - 2012
12.	CF/IDP/02	Resource damage assessment in marine fisheries: impact of selective fishing of juveniles and bycatch and discards in trawl fisheries	Dr. E.V. Radhakrishnan	2007 - 2012
13.	MF/IDP/02	Application of trophic modeling in marine fisheries management	Dr. K.S. Mohamed	2007 - 2012
Marine Environment				
14.	FEM/01	Impact of anthropogenic activities on coastal marine environment and fisheries	Dr. P. Kaladharan	2007 - 2012
15.	FEM/02	Impact and yield study of environmental changes on distribution shifts in small pelagics along the Indian coast	Dr. K. Vijayakumaran	2007 - 2012
Mariculture				
16.	MD/IDP/01	Technology development for seed production of shellfish	Dr. K.R. Manmadhan Nair	2007 - 2012
17.	MD/IDP/02	Technological upgadation of molluscan mariculture	Dr. P.K. Asokan	2007 - 2012
18.	MD/IDP/03	Development of broodstock, captive breeding and seed production techniques for selected marine food fishes and ornamental fishes	Dr. G. Gopakumar	2007 - 2012

Sl. No.	Project Code	Name of the Project	Name of PI	Duration
19.	MD/IDP/04	Innovations of sea cage farming and development of sustainable Capture Based Aquaculture (CBA) systems	Dr. G. Syda Rao	2009 - 2011
20.	MD/05	Conservation mariculture of selected species	Dr. I.Jagadis	2009 - 2011
Marine Biotechnology				
21.	MBTD/NUT/01	Formulation and evaluation of larval and growout feed for marine crabs, lobsters, ornamentals and cage farmed finfish	Dr. P. Vijayagopal	2007 - 2012
22.	MBTD/PATH/01	Pathogen profiling, diagnostics and health management in maricultured finfish and shellfish	Dr. K.K. Vijayan	2009 - 2012
23.	PNP/BIOT/02	Biotechnological applications in mariculture and conservation	Dr. P.C. Thomas	2007 - 2012
Marine Biodiversity				
24.	MBD/RE/01	Understanding the threatened coral reef ecosystems of southern India and designing interventions aimed at their restorations	Dr. Mary K. Manisseri	2007 - 2012
25.	MBD/RE/04	Species variation and biodiversity of fishes of the family Lutjanidae in the Indian seas	Dr. K.K. Joshi	2008 - 2010
26.	MBD/RE/05	Assessment of biodiversity and ecological impact in open sea cage farming	Dr. K.Vinod	2009 - 2011
Socio-Economics and Extension				
27.	SEE/PEM/01	Benefit-cost assessment of marine fishery business and alternative investment options	Dr. R. Narayanakumar	2007 - 2012
28.	SEE/PMS/01	A diagnostic study on dimensions, causes and ameliorative strategies of poverty and marginalisation among the marine fisherfolk of India	Dr. C. Ramachandran	2007 - 2012
29.	SEE/PET/01	Impact of WTO regulations in Indian fisheries trade: a policy perspective	Dr. Shyam S. Salim	2009 - 2011

Sponsored projects

Sl. No.	Name of the Project & PI	Funding agency	Duration
Marine Resource Assessment			
1.	Impact, adaptation and vulnerability of Indian Agriculture to climate change (II Phase) PI: Dr. E. Vivekanandan	ICAR Network	2007 - 2012
2.	Assessment of myctophid resources in the Arabian Sea and development of harvest and post harvest technologies PI: Dr. N.G.K. Pillai	MoES	2007 - 2012
3.	Validation of PFZ advisories brought out by INCOIS among artisanal and small mechanized sector fishermen along Kerala coast to compare the advantages derived for different types of fishing operations/targeted species PI: Dr. V.N. Pillai, Emeritus Scientist	INCOIS, Hyderabad	2008 - 2012
4.	Studies on marine mammals of Indian Exclusive Economic Zone and the contiguous seas (II Phase) PI: Dr. E. Vivekanandan	MoES	2007 - 2012

Sl. No.	Name of the Project & PI	Funding agency	Duration
5.	Establishment of four artificial reefs by fishermen on participatory mode along Tamil Nadu coasts for marine fishery resource enhancement (with the involvement of NGO, PLANT) PI : Dr. H. Mohammed Kasim	Tamil Nadu Fisheries Department	2008-2010
6.	Assessment of fishery resources along the Indian continental slope and Central Indian Ocean PI: Dr. U. Ganga	MoES	2007- 2012
7.	Participatory management and conservation of lobster resources along the south-west coast of India PI: Dr. E.V. Radhakrishnan	MPEDA	2002 - 2009
Mariculture			
8.	Open sea floating cage demonstration farm for R&D in marine finfish and shellfish production PI: Dr. G. Syda Rao	MoA	2005 - 2010
9.	Open sea cage culture demonstration farms in India PI: Dr. G. Syda Rao	NFDB	2008 - 2010
10.	Farming and pearl production in the black lip pearl oyster *Pinctada margaratifera* in Andaman and Nicobar Islands PI: Dr. K.S. Mohamed	MoES	2003 - 2012
11.	Demonstration and transfer of technology of marine pearl culture *Pinctada fucata* PI: Dr. V. Kripa	MoES	2007 - 2012
12.	Development of shallow water grow-out techniques for the venerid clam, *Paphia malabarica* (Chemnitz) and the corbiculid clam, *Villorita cyprinoides* (Grey) PI: Dr. N. Suja Mentor: Dr. K.S. Mohamed	DST-Womens Scientists Scheme	2008 - 2011
13.	Seed production in agricultural crops and fisheries PI: Dr. K. Madhu	ICAR	2006 - 2010
Marine Biotechnology			
14.	Bio-prospecting of genes and allele mining for abiotic stress tolerance PI: Dr. K.K. Vijayan	NAIP	2009 - 2012
15.	Development of species specific DNA markers in economically important shellfish species green mussel (*Perna viridis*) and edible oyster (*Crassostrea madrasensis*) for their application in farming and resource management PI : Dr. K.K. Vijayan	DBT	2007-2010
16.	Development of genetically improved strains of Brine Shrimp Artemia using quantitative and molecular genetic tools PI : Dr. P.C. Thomas	DBT	2008 = 2011
17.	Establishment and chararacterization of cell lines from selected marine food fish and ornamental fish PI: Dr. K.S. Sobhana	DBT	2008 - 2011
18.	Fast track scheme: Characterization of novel antioxidants from red and brown seaweeds from Gulf of Mannar PI: Dr. Kajal Chakraborty	DST	2007 - 2012

Sl. No.	Name of the Project & PI	Funding agency	Duration
Marine Microbiology			
19.	Application of Microorganisms in Agriculture and Allied Sectors (AMAAS): Development of library putative probionts from marine environment belonging to the genus *Pseudomonas, Micrococcus* and *Bacillus* for application in mariculture systems PI: Dr. K.K. Vijayan	ICAR Network NBAIM-Mau	2008 - 2010
20.	Application of Microorganisms in Agriculture and Allied Sectors (AMAAS): Microbial diversity and identification - Fish microbes PI: Dr. Imelda Joseph	ICAR Network NBAIM-Mau	2006 - 2011
Value Chain Projects			
21.	A value chain on oceanic tuna fisheries in Lakshadweep Sea PI: Dr. E.V. Radhakrishnan	NAIP	2007 - 2012
22.	Export oriented marine value chain for farmed sea food production using Cobia through rural entrepreneurship Dr. G. Gopakumar	NAIP	2009 - 2012
23.	Utilization strategy for oceanic squids (Cephalopoda) in Arabian Sea : A value chain approach PI: Dr. K.S. Mohamed	NAIP	2009 - 2012
24.	A value chain on high value shellfishes from mariculture systems PI: Dr. V. Kripa	NAIP	2009 - 2012
Outreach Projects			
25.	ICAR outreach activity on fish genetic stocks PI: Dr. P.C. Thomas	ICAR	2008 - 2012
26.	ICAR outreach activity on fish feeds PI: Dr. P. Vijayagopal	ICAR	2008 - 2012
27.	ICAR outreach activity on nutrient profiling and evaluation of fish as a dietary component PI: Dr. Kajal Chakraborty	ICAR	2008 - 2012
Projects initiated in 2009			
28.	Bioinventorisation of coral fishes of South India with special reference to threats and conservation measures PI: Smt. Rekha J. Nair	MoEF	2009 - 2012
29.	Strategies to enhance adaptive capacity to climate change in vulnerable regions PI: Dr. V.V. Singh	NAIP	2009 - 2012

Consultancy projects

Sl. No.	Title	Client
1	Planning, construction and management of sweet, brackish and marine aquariums	Surat Municipal Corporation Surat, Gujarat
2	Survey inventorisation database creation of marine and coastal aquatic biodiversity in the three coastal districts of Karnataka	Karnataka State Biodiversity Board, Bangalore
3	Post-commissioning environmental impact assessment of sewage outfall operations on the fishery of the west coast of Mumbai	M/s. NEERI Mumbai Zonal laboratory Worli, Mumbai- 400018
4	An assessment of fish production and likely financial losses to fishers due to development of Rewas-Aware Port	M/s. Maharashtra Maritime Board Indian Mercantile Chambers R.K. Marg, Ballard Estate, Mumbai- 400038.

Sl. No.	Title	Client
5	Impact of development of a jetty at Killa bunder on fishing activities in Vasai Creek	Maharashtra Maritime Board Indian Mercantile Chambers, R.K. Marg, Ballard Estate, Mumbai- 400038
6	Socio-economic survey of fishermen in Pondicherry and Karickal regions.	M/s. Project Implementation Agency, A -Block, PKC Educational complex Anna Nagar, Puducheri
7	Installation of water purification and life support systems, ecosystem development and live stock malignance in the marine aquarium at Surat (Phase-II).	Surat Municipal Corporation, Surat, Gujarat
8	Shrimp nutrition for specific pathogen-free (SPF) tiger shrimp.	RGCA, Kodiyaghat, Burmanala P.O., Garacharma, Andaman- 744105
9	Installation of artificial reef to enhance biological resources and livelihood of fishermen	M/s. Chennai Water Desalination Ltd., Guindy, Chennai- 600032.
10	Monitoring chemical parameters of effluent and the hydrobiological conditions in the Arabian Sea off Chitrapur (Phase-10)	M/s. MRPL, Mangalore
11	Advisory on screening of OIE listed pathogens relevant to Kerala, India.	M/s. KAVIL, Salim Ali Road, Ernakulam North P.O., Kochi-602018.
12	Breeding technology of *Amphiprion ocellaris*	M/s Abad Hatchery, Kandakadavu P.O, Chellanam, Ernakulam
13	Whale shark conservation	Executive Director, Wild Life Trust of India B-13, 2nd Floor, Sector VI, NOIDA, UP

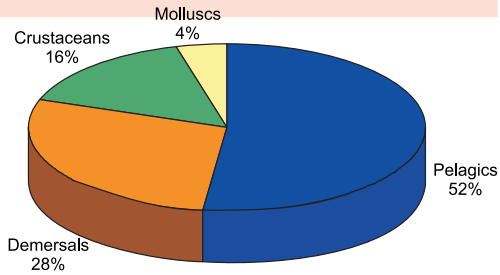
IN-HOUSE PROJECTS

Marine Capture Fisheries

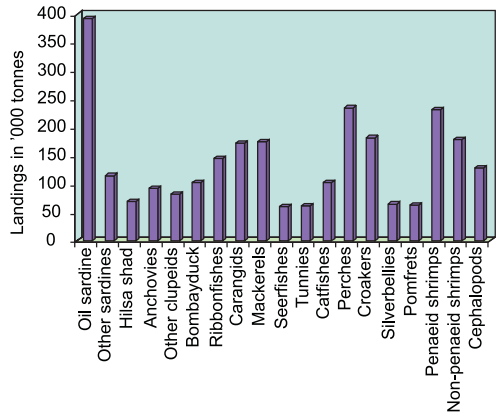
PROJECT CODE	**FRA/ASSESS/01**
PROJECT TITLE	**Development of knowledge based information system for marine fisheries sustainability**
SCIENTISTS	**T.V. Sathianandan,** J. Jayasankar, Somy Kuriakose, T.M. Najmudeen, K.G. Mini and Wilson T. Mathew
CENTRE	Kochi

- The aim of the project is to estimate individual species-wise as well as gear-wise marine fish landings and fishing effort for different regions of the country in order to develop a full fledged information retrieval system pertaining to marine fisheries. The stratified multistage random sampling design was adopted for collection of data and estimation of exploited marine fish landings. The estimation of individual species-wise landings for each state was carried out and added to the Access database for first, second and third quarters of 2009 using the software developed in C^{++} and Visual Basic.
- The estimate of region-wise production showed that the north-west region comprising Maharashtra and Gujarat contributed 26% to the total production, and the south-west region comprising Kerala, Karnataka and Goa contributed 30%. On the east coast, north-east region, comprising West Bengal and Orissa recorded 20% of the total, whereas the south-east region consisting of Andhra Pradesh, Tamil Nadu and Puducherry contributed 24%.

- *The marine fish landings of India in 2009 has, provisionally been estimated as 3.16 million t with a decrease of about 43, 891 t against the estimate of the previous year.*
- *The pelagic finfishes constituted 52%, demersal fishes 28%, crustaceans 16% and molluscs 4% of the total landings.*
- *The sector-wise contributions in 2009 were: mechanized 74%, motorized 22% and artisanal 4%.*
- *The west coast and east coast accounted for 56% and 44% respectively.*



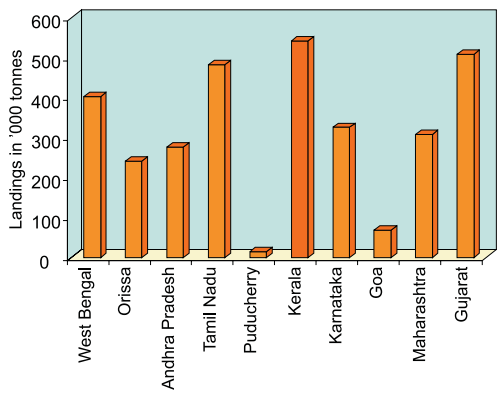
Components of marine fish landings in India during 2009



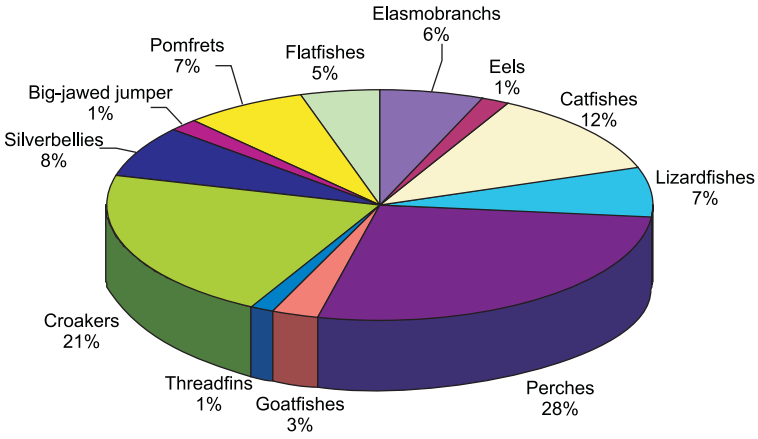
Landings of major fishery resources in India during 2009

Contribution of major species/groups

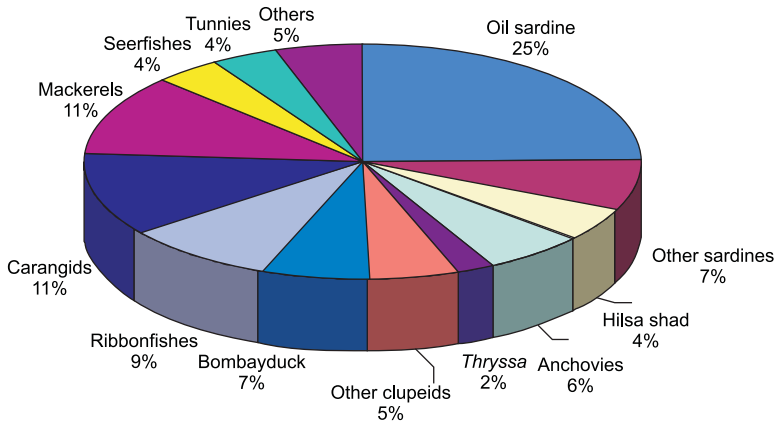
- The estimated landings of oil sardine was 3,92,486 t in 2009 as against 4,44,593 t in the previous year, which formed 12.4% of the total marine fish landings in India.The landings of lesser sardines was 1,15,343 t which was on par with that of 2008. A drastic reduction of about 40% was noticed in the landings of *Stolephorus* spp., the estimated landings being 52,739 t in 2009. The landings of Bombayduck decreased to 1,03,489 t from 1,04,969 t in 2008. The landings of ribbonfishes were 1,45,635 t which was in the same level as that of 2008. Indian mackerel, one of the major single species contributor (5.5%) increased to 1,74,760 t from 1,58,913 t in 2008.
- Catfish landings recorded an increase of about 12% in 2009, with an estimate of 1,03,320 t. Threadfin bream landings in the current year being 1,31,263 t, registered an increase of 3.4% from that of the previous year. In 2009, croaker landings was 1,82,109 t which did not show much variation as compared to the previous year. Landings of silverbellies came down to 65,034 t from 70,059 t in 2008.



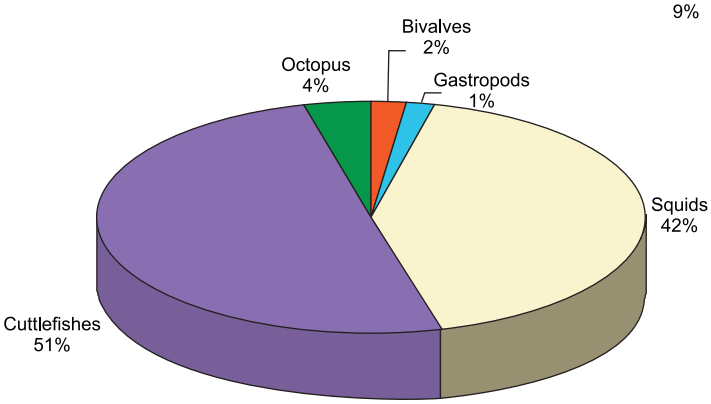
State-wise landings in India during 2009



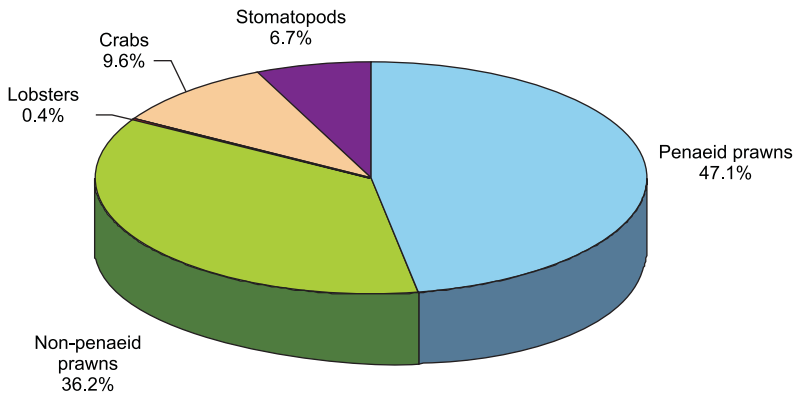
Demersal finfishes



Pelagic finfishes



Molluscs



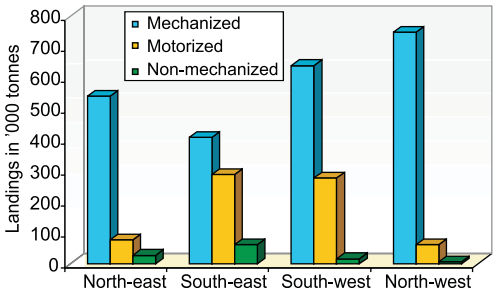
Crustaceans

Components of various groups in the marine fish landings during 2009

Estimated marine fish landings (t) during 2008 and 2009*

Group	Pelagic finfishes 2008	2009	Group	Demersal finfishes 2008	2009
CLUPEOIDS			ELASMOBRANCHS		
Wolf herring	23241	27655	Sharks	26710	29126
Oil sardine	444593	392486	Skates	3530	3582
Other sardines	116101	115343	Rays	18219	20980
Hilsa shad	58875	69231	EELS	10805	12846
Other shads	7560	5852	CATFISHES	92357	103320
Coilia spp.	31243	27579	LIZARD FISHES	52439	56571
Setipinna sp.	10040	11931	PERCHES		
Stolephorus spp.	87687	52739	Rock cods	19517	17694
Thryssa spp.	36228	38391	Snappers	8580	7599
Other clupeids	69938	82858	Pig face breams	11821	18230
BOMBAYDUCK	104969	103489	Threadfin breams	126943	131263
HALF BEAKS &			Other perches	83985	60132
FULL BEAKS	6547	6874	GOATFISHES	22251	24326
FLYING FISHES	1559	1063	THREADFINS	10003	11895
RIBBON FISHES	145398	145635	CROAKERS	181810	182109
CARANGIDS			SILVERBELLIES	70059	65034
Horse Mackerel	30668	35723	WHITEFISH	8625	12552
Scads	35793	50739	POMFRETS		
Leather-jackets	12434	13153	Black pomfret	18880	20450
Other carangids	69835	73374	Silver pomfret	29281	37433
MACKERELS			Chinese pomfret	3834	4927
Indian mackerel	158913	174760	FLAT FISHES		
Other mackerels	14	0	Halibut	1001	890
SEER FISHES			Flounders	156	145
Scomberomorus			Soles	38330	39975
commerson	33012	32878	MISCELLANEOUS	29223	30209
S. guttatus	23796	27228	Total	868359	891288
S. lineolatus	16	16	**SHELLFISH**		
Acanthocybium spp.	61	185	CRUSTACEANS		
Other seerfish	3	0	Penaeid prawns	213327	232313
TUNNIES			Non-penaeid prawns	187173	178504
Euthynnus affinis	32406	28563	Lobsters	1974	1968
Auxis spp.	8693	8780	Crabs	55700	47462
Katsuwonus pelamis	13088	5735	Stomatopods	30532	33109
Thunnus tonggol	5939	3808	MOLLUSCS		
Other tunnies	19534	15086	Cephalopods		
BILL FISHES	6054	8166	Squids	81594	56704
BARRACUDAS	19140	23048	Cuttle fishes	73425	66336
MULLETS	8407	6220	Octopus	5301	5652
UNICORN COD	787	870	Miscellaneous	10742	4758
MISCELLANEOUS	56506	55762			
Total	**1679078**	**1645220**	**Total**	**659768**	**626806**
			Grand total	**3207205**	**3163314**

* Provisional estimate



Sector-wise landings in different regions during 2009

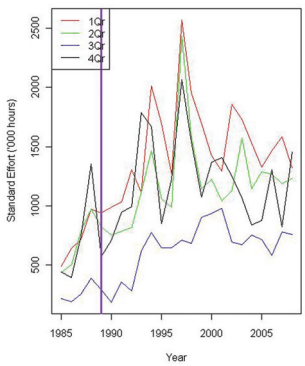
- Penaeid shrimp landings accounted for an increase of 8.9% in 2009, the estimate being 2,32,313 t. The estimated landings for non-penaeid shrimp was 1,78,504 t. As compared to 2008, a decrease of 4.6% was noticed in the landings. The estimate of cephalopod landings was 1,28,692 t during 2009 with a decline of about 20% as that of 2008.
- As part of digitization of historical data on marine fish landings, species coding was done for the years 1986, 1987 and 1988. The data of 1988 for all the maritime states were digitized into Access database.

PROJECT CODE FRA/ASSESS/02

PROJECT TITLE **Decision support system for marine fisheries management**

SCIENTISTS **J. Jayasankar,** T.V. Sathianandan, Somy Kuriakose, K.G. Mini and Wilson T. Mathew

CENTRE Kochi



Kerala - Quaterwise standardised efforts for penaeid prawns

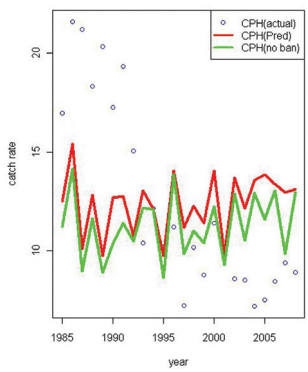
- The first two years of the project concentrated more on the practicality of utilizing Bayesian routines in Indian conditions for the analysis of data on catch and effort. The various possibilities of non-informative priors applicable for the main Schaefer's constants of the Biomass dynamic model were studied in detail. During the present year (2009- 10), development of a software was given priority. Apart from an effort that was being persisted with to code Gibbs sampling variant of Markov Chain Monte Carlo algorithm for estimating the conditional distribution of the Schaefer's model, a conscious attempt was made to prune up the various modules prepared for analyzing the field data using traditional methods. The popular methods considered were the following:

(i) Length-weight relationship (log linear regression)

(ii) Thompson-Bell prediction model

(iii) Virtual Population Analysis (length cohort based)

- The various routines prepared by the FRA Division at various points of time, were collated and reviewed and suitably made amenable to be used under one menu driven GUI application using VB Net. The trials were carried out successively.
- On the Bayesian front, attempts were made to try other possibilities of MCMC algorithm like Metropolis-Hastings within Gibbs alternative as suggested by Gilks (1996). Towards achieving this, post-1985 data on standardized catch and effort of various states/ regions of the country were analysed. The scenario as thrown up by the Schaefer's model in case of effort moderation was also checked for amenability to this procedure.
- As a parallel development, coding is in progress for the Bayesian algorithm based on another established logic - "Adaptive Rejection" technique. Once finalized, these algorithms would be incorporated as modules in the GUI being prepared for this purpose alongside the traditional fishery management indices.



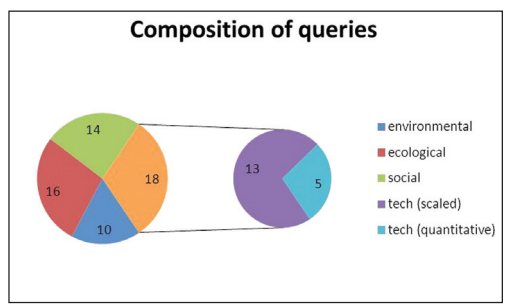
Kerala - Quaterwise catch rate for penaeid prawns: actual, predicted and no ban scenario

PROJECT CODE	FRA/IDP/01
PROJECT TITLE	**Sustainability profiling of major fisheries off Kerala coast - a Multi Dimensional Scaling approach**
SCIENTISTS	**J. Jayasankar,** E. Vivekanandan, R. Sathiadhas, T.V. Sathianandan, P.T. Sarada, C. Ramachandran, Somy Kuriakose, T.M. Najmudeen, V.P. Vipin Kumar and K.G. Mini
CENTRES	Kochi and Calicut

- The primary aim of this project is to project various fisheries, gear based, resource based as well as location based, on a comparable metric mapping, based on multiple facets of factors contributing to sustainability. The project was launched to cover the fisheries of southern, middle and northern parts of Kerala with specific focus on fisheries of small pelagics as well as crustaceans and also to analyse the intra-state differences prevailing around the major harbours like Neendakara, Munambam and Cochin Fisheries Harbour. As per the programme, rapid appraisal efforts were carried out in two approaches. The first one was the collection and collation of published information on various aspects: biological, technological, economic and social aspects pertaining to the locations under focus. Accordingly, during the past year, published records on the following parameters have been collected and stored as a database.

Attribute	Description
Reference	Species name, family name, ISSCAP code *etc*.
Locality	Where the study was conducted
Gear	Gear used for sampling
K	Annual growth rate
M	Natural mortality
F	Fishing mortality
Z	Total mortality
t_0	Age at genesis
SSB	Spawning stock biomass
MSY	Various estimates of Maximum Sustainable Yields
L_r	Length at recruitment
L_∞	Asymptotic length
t_r	Age at recruitment
t_c	Age at first capture

- Apart from these syndicated research output, certain other relevant information on the price fetched by species under focus as well as the trophic levels of the animals under study was also collected and processed to suit analysis.
- To get information on various other issues pertaining to sustainability, during 2009-10, parameters of distinct contribution to the facets of social, technological, economic and ethical domains were finalized using the Delphi process involving the experts in the field. The final set of questions incorporated in the schedule is summarized in the figure.



- The questions were prepared to target three major groups of respondents, *viz*., core fishermen, marketing hands and observers. Though the questions were supposed to be responded at an individual level, provisions were made to incorporate opinions based on

interactive evidence on areas which were not directly handled by the individual. Further to the level possible, the questions were targeted to be focused on a particular gear or resource so that the responses add up to building the picture of a particular fishery. The planned sampling scheme is to cover two rounds and the first round is planned to be conducted in May- June 2010 and the second three months thereafter.

The following is the schematic proportional sampling plan to be executed.

Area	Trawl	Seine	Hooks and Lines
South		VJM	
Middle	CFH, NDK, MUN	CFH	CFH
North	BEY	PUD,CHO	PUD,CHO,BEY

(VJM- Vizhinjam; CFH- Cochin Fisheries Harbour; NDK- Neendakara; MUN- Munambam; BEY- Beypore; PUD- Pudiyappa; CHO- Chombala)

PROJECT CODE **PEL/IDP/01**

PROJECT TITLE **Management advisories for sustaining marine fisheries of Kerala and Lakshadweep**

SCIENTISTS **M. Sivadas,** N.G.K. Pillai, E. Vivekanandan, E.V. Radhakrishnan, K.S. Mohamed, U. Ganga, E.M. Abdussamad, T.S.Velayudhan, Somy Kuriakose, Rekha Devi Chakraborthy, Lakshmi Pillai, C. Ramachandran, P.T. Sarada, P.P. Manoj Kumar, Grace Mathew, S. Jasmine, N. Ramachandran, K.N. Saleela and K.P. Said Koya

CENTRES Kochi, Calicut and Vizhinjam

- Marine fish landings along the Kerala coast in 2009 was 5,17,591 t which showed a decrease of 22% compared to 2008. Pelagic finfish resources contributed 67%, demersal finfish 17%, crustaceans 11% and molluscs 5%. Sector-wise landings indicated that, mechanized sector contributed 59%, motorized 39% and artisanal sector 2%.
- The major gears that contributed to the fishery were ring seines 45.7%, multiday trawlers 25.7%, outboard motor operated gillnet 7.6% and mechanized single day trawlers 4.9%. Catch per unit hour in mechanized ring seine was 975 kg compared to 575 kg in outboard ring seines and 958.5 kg in mechanized purse seines.
- Quarter-wise, the III quarter (July - September) contributed 32% followed by I quarter (January -March) with 24%. The IV (October – December) and II (April –June) quarters contributed 23% and 21% respectively.
- District-wise production showed that Ernakulam contributed the highest (20.5%) followed by Kozhikode (15.6%), Kollam (12.3%), Malappuram (11%), Thrissur and Alleppey (9.6% each), Trivandrum (8.3%), Kannur (6.8%) and Kasaragod (6.3%).

Landing of mechanized ring seine

Pelagics

- The total pelagic landings were 3.45 lakh t which formed 66.6% of the total landings. But the landings showed a reduction of 26.6% compared to the previous year.
- Oil sardine *Sardinella longiceps* landings declined by 28% compared to previous year. However, it was the major contributor forming 48.6% of the total pelagic resources and 32.3% of the total landings. Ring seine landed 95% of the total landings. Oil sardine landing was

completely absent in Trivandrum district. Size range along central Kerala region was 80-180 mm in the ring seine and 115-180 mm in trawl.

- Mackerel was landed mainly by ring seine (60%), outboard gillnets (20.7%) and trawls (7.9%). Along central and south Kerala, the size range was 100-270 mm in ring seine. Peak spawning was noted during April-May and in November.
- White baits (*Stolephorus* spp.) were landed by ring seine (53%), trawl net (25%) and boat seine (19.7%). Species composition revealed dominance of *Stolephorus commersonii* in central Kerala and *S. devisi* in southern area. Size range of *S. devisi* was 60-95 mm and 60-100 mm in central/south Kerala and Malabar respectively whereas *S. commersonii* ranged in size from 75-120 mm and 80-145 mm in central/south Kerala and Malabar respectively. All the fishes were found to be mature.
- Tunas were exploited mainly by gillnets and hooks and lines. Fishery occurred round the year with the peak in April and during September-November. Fishery was supported by eight species at Cochin. Among coastal tunas, *Euthynnus affinis* dominated whereas in deepsea tunas *Thunnus albacares* and *Katsuwonus pelamis* were the dominant species. Commercial size range of *E. affinis* was 30-68 cm with the mode at 52 cm. *Auxis thazard* ranged in size from 20-50 cm with 35 cm as mode and size variation of *A. rochei* was 14-34 cm with 31 cm as mode. Relative fecundity of *E. affinis*, *A. thazard* and *A. rochei* were 92,139, 1,06,072 and 33,37,573 eggs respectively. The major food item was found to be fishes. The exploitation of *E. affinis* was found to be slightly above optimum level and that of *A. thazard* was very close to the optimum level. Exploitation of *A. rochei* was well below the optimum level.
- At Vizhinjam, the tuna fishery was constituted by six species. The size of *A. rochei* ranged from 18-36 cm in drift net and from 15-34 cm in trawls with the mode at 26 and 27 cm in both. *E. affinis* varied from 31 to 42 cm with the main mode at 37 cm. Mature and partially spent fishes dominated during monsoon season.
- Out of the total landing of 3,472 t of bill fish, 64% was landed at Ernakulam and 34% at Trivandrum. The fishery was represented by *Istiophorus platypterus*, *Makaira indica* and *Xiphias gladius*.
- Seer fishes were exploited mainly by gillnets, hooks and lines, ring seines and trawls. Fishery was available throughout the year with peak during September-October. *Scomberomorous commerson* was the most dominant species. *S. commerson* ranged in size from 48-134 cm in hooks and lines/gill nets. In trawls, the size range was 20-68 cm. The peak was during June to September. Study on exploitation indicate heavy fishing pressure on the stock.
- Carangid landing in Kerala was 37,721 t forming 7% of the total landings and 10.9% of pelagic landings. At Cochin, the fishery was supported by 33 species with 12 at commercial level. In trawl, *Decapterus* spp. dominated. In gillnet/hooks and lines, *Caranx ignobilis* dominated. *D. russelli* fishery was comprised by size groups of 135-225 mm. In *S. crumenophthalmus*, the size range

Juvenile yellowfin tuna landings at Cochin Fishereies Harbour

Landings of *Stolephorus* spp.

Landings of sailfish *I. platypterus* at Cochin Fisheries Harbour

Landings of cobia *R. canadum* at Cochin Fisheries Harbour

Landing of shark *C. limbatus* at Cochin Fisheries Harbour

Landings of threadfin bream *N. mesoprion*

was from 170 to 290 mm. The food of scads comprised of small fishes, prawns, squid *etc.* whereas that of horse mackerel was comprised by anchovies, shrimps, *Acetes*, copepods *etc.* Stock assessment indicated that both *D. russelli* and *S. crumenophthalmus* are under exploited.

- Ribbonfish fishery was exclusively exploited by trawls. The production was 6031 t forming around 1.2% of total production. Fishery was supported by single species, *Trichiurus lepturus*. The size range was 30-96 cm.
- Cobia (*Rachycentron canadum*) was exploited by gillnets/hooks and line and trawls. Size range in the fishery was 28-160 cm. Immature as well as ripe animals were present. Fecundity varied between 2.1 and 3.8 million. Diet was mainly comprised of finfishes. The price at Cochin varied between Rs.150 - 220 per kg.

Demersals

- In 2009, an estimated 86,781 t of demersal fishes were landed which showed a reduction of 9.7% compared to the last year. The major contributor among the demersal fishes was threadfin breams (37.5%). There was slight increase in the landings of threadfin breams and elasmobranches while lizard fish, croakers *etc.* showed marginal decrease compared to 2008.
- Sharks (60%), skates (8%) and rays (32%) contributed to the elasmobranch fishery. *Carcharhinus limbatus* was the dominant species of sharks found in all the gears. The spawning stock biomass of *C. limbatus* along Malabar coast was more than 20% of the virgin stock biomass.
- Threadfin bream fishery along the Malabar coast showed an increase of 61% compared to previous year. *Nemipterus mesoprion* dominated the fishery. In the case of *N. mesoprion* immature and mature fishes dominated with a contribution of 46.2% and 51.9% respectively, while the contribution of spent fishes was only 1.8%. *Acetes* spp., crabs, *Cynoglossus* spp., cuttle fishes, *Decapterus* spp., deepsea prawns, *Loligo* spp., octopus, penaeid prawns and *Stolephorus* spp. were the chief food items observed in the stomachs of *N. japonicus* and *N. mesoprion*. The exploitation rate (E=0.68) is currently above the optimum level in *N. mesoprion* and *N. japonicus*, but the spawning stock biomass estimated in both the species is more than 30% of the stock at its unexploited level.
- Flatfishes are caught by mechanised, motorized and traditional gears. The annual flatfish catch during this period was 7,739 t forming 3.76% of the marine fish landing in Malabar region. Catch in Multiday trawl units has shown a five fold increase. *C. macrostomus* (79.4%) was the dominant species found in the fishery. Immature (39.9%) and spent fishes (36.8%) dominated the fishery of *C. macrostomus*. The spawning stock biomass estimated is more than 30% of the annual stock at its unexploited level. This indicates that the resource is having sufficient regeneration capacity.
- Sciaenid landings in Kerala were estimated at 8,742 t showing a decrease of 17 % compared to previous year. *Johnius sina* remained dominant species in trawl and ring seine, while *O. ruber* and *O. cuvieri*

were the dominant species found in gillnet. Mature (51.7%) and spent fishes (28.2%) were dominant in the fishery of *J. sina*. Although *J. sina* and *O. ruber* are heavily exploited, the spawning stock biomass estimated for both the species is more than 25% of the resource at its unexploited level which is a good indicator showing regeneration capacity of the resource.

- The total landings of groupers were 2,123 t. *Epinephelus diacanthus* was the major species in the trawl nets and in the hooks and lines at Cochin. The size range of *E. diacanthus* from trawl nets was from 100 - 322 mm. In the trawl nets, indeterminates and immature fishes constituted 73.7% of the catch and around 26.4% were maturing fishes which were predominantly 1+ year class fish. In hooks and lines, *E. diacanthus* in the size range of 242 - 544 mm was observed. Being protogynous hermaphrodite, females were encountered more in the fishery. Transforming males were observed in hooks and line catches. Nearly 50% of females from hooks and line catches were immature females, 37% were maturing and very few mature fishes were observed.
- At Cochin Fisheries Harbour, the catch of priacanthids from trawlers was 165.4 t forming 0.15% of the total fish catch from trawls. Compared to the previous year, there was a tremendous decline in the catch (457.8 t) as well as catch rate (1.62 kg) of priacanthids from trawl nets. Peak landings were during the post-monsoon season from August-October, immediately after the trawl ban along Kerala coast. *Priacanthus hamrur* constituted 90% of the catch. The size range of *P. hamrur* was from 130 - 384 mm. Females predominated the catch with a male:female ratio of 1:1.7. Mature fishes were found more during January - April. At Neendakara Fisheries Harbour also priacanthid fishery in 2009 (694.8 t) showed a decline, compared to the previous year with a catch of 909.7 t.

Landings of grouper *Epinephelus diacanthus*

Fishery related parameters of some important demersal resources in Kerala

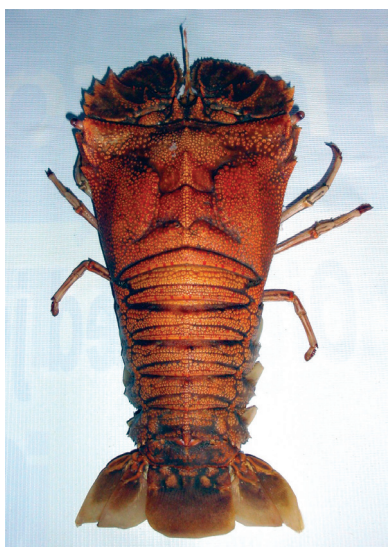
Species	Length range (mm)	Mean size (mm)	Fishery dominant size group (mm)	Exploitation ratio (E)	Spawning stock biomass (t)		Standing stock biomass (t)	
					Kerala	Malabar	Kerala	Malabar
C. limbatus	374-2174	1092.4	800-1800	0.69	556	32	1085	62
N. mesoprion	42-308	140.3	120-160	0.68	4009	1739	6762	2933
N. japonicus	32-298	134.5	150-200	0.61	5361	2729	6667	3351
C. macrostomus	22-166	94.7	90-140	0.45	4156	2920	8284	5524
J. sina	22-238	120.1	90-150	0.65	5283	2345	9563	4066
O. ruber	72-298	189.3	130-200	0.71	409	163	555	220

Crustaceans

- An estimated 55,473 t of crustaceans was landed registering a decrease of 1.7% compared to previous years catch. The estimated penaeid shrimp landings by trawlers at Cochin Fisheries Harbour from inshore grounds amounted to 4,015 t during the period with catch rate of 9.0 kg h^{-1}. The main contributors to the fishery were *Metapenaeus dobsoni* (59%) and *Parapenaeopsis stylifera* (32%) followed by *M. monoceros* (198 t, 5%) and *Fenneropenaeus indicus* (58 t, 1.4%). Length range of *M. dobsoni* in the fishery was 46-95 mm for males

Landings of deepsea shrimp *A. alcocki*

P. stylifera landings at Sakthikulangara - Neendakara



Dorsal view of the slipper lobster *Thenus orientalis*

and 51-120 mm for females. Although mature females were observed throughout the year, the peak breeding seasons for *M. dobsoni* were April-May and November-December. Total length of *P. stylifera* varied between 46-95 mm and 46-110 mm for males and females respectively. Although mature females were found throughout the year, the peak breeding seasons were found during April-May and November-December.

- The average estimated deep sea inshore shrimp catch landed at Cochin Fisheries Harbour during the period formed 813 t with a catch rate of 1.8 kg h^{-1}. *Plesionika spinipes* (48%) was the main constituent among pandalid shrimps followed by *Heterocarpus gibbosus* (39%). Important penaeid species were *Aristeus alcocki* (89%) followed by *Metapenaeopsis andamanensis* (11%).
- The average estimated shrimp catch from the inshore grounds landed at Sakthikulangara-Neendakara centers during the period was 4,693 t with a catch rate of 9.3 kg h^{-1}. The length of *P. stylifera* ranged from 51-110 mm for females and 46-95 mm for males. Peak breeding season was found during April-May and November-December. Females outnumbered males throughout the year except in January forming 58.3% of the annual catch during the period. The size of *M. dobsoni*, ranged from 46-100 mm and 51-120 mm in males and females respectively. The average estimated deepsea penaeid shrimp catch from Quilon Bank landed at Sakthikulangara during the period amounted to 4,693 t with a catch rate of 9.3 kg h^{-1}. Catch has been observed to decrease by 18% and the catch rate by 5 kg h^{-1}. Among the pandalids, *P. spinipes* (24%) dominated the catch while *A. alcocki* (19%) dominated the penaeid catch. The average estimated deepsea non-penaeid shrimp catch from Quilon Bank landed at Sakthikulangara during the period amounted to 2,769 t with a catch rate of 13.7 kg h^{-1}.
- The total shrimp catch in the Malabar region was 16,519 t registering an increase of 22% over last year. Mechanised trawl net contributed 81% of the catch. Of the 10 species landed, *M. dobsoni* dominated (39%). In *M. dobsoni*, the size range of male and female were 46-95 mm and 46-105 mm respectively. The main spawning season was in December and May. Females dominated (62%) in the landings. Females dominated in all the species except for *M. monoceros*. In maturity condition of females, the spent stage dominated in all the species.
- Crab landings from the Malabar coast was 1,597 t showing a decrease of 9% compared to last year. Crab catch was comprised by *Charybdis feriatus* (50.2%), *Portunus sanguinolentus* (47%), *P. pelagicus* (2.3%) and *C. lucifera* (0.5%). The sizes of male and female were 46-140 mm and 46-145 mm respectively in *P. sanguinolentus*. In *C. feriatus*, the size range in male was 41-125 mm and in female, it was 61-145 mm. Females dominated in *P. sanguinolentus* and *C. feriatus* whereas males dominated in *P. pelagicus*. Mature specimens dominated in *P. pelagicus* and immature ones in *C. feriatus*. In *P. sanguinolentus*, the percentage contribution of immature, mature and berried stages was almost equal.
- 59 t of lobsters landed by trawlers with a catch rate of 0.34 kg h^{-1} at Sakthikulangara, south-west coast of India
- The slipper lobster occurring along the south-west coast of India is *Thenus unimaculatus* hitherto known as *T. orientalis*

Population parameters of shrimps

Species	K		L_∞		M	
	M	F	M	F	M	F
M. dobsoni	2.1	2.4	109	128	2.33	2.23
P. stylifera	2.5	2.2	110	138	2.79	2.48
F. indicus	1.8	2	178	191	2.06	2.21
M. monoceros	1.7	1.75	164	197	1.98	2.06

Population parameters of crabs

Species	L_∞	K	M	Z
P. sanguinolentus	165	1.9	2.77	7.2
C. feriatus	165	1.3	2.97	6.0

Molluscs

- The total cephalopod landing was 25,478 t of which 52% was comprised by cuttlefishes, 36% by squids and the rest by octopus. The landings showed a drastic reduction of around 45% compared to the last year.
- The cephalopod fishery at Vizhinjam was comprised by *Loligo duvauceli* (82.9%), *Doryteuthis singhalensis* (10.6%) and *Sepia pharaonis* (6.5%). The exploitation rate of *S. pharaonis, L. duvauceli* and *D. singhalensis* were 0.69, 0.73 and 0.03 respectively. Estimated fishing mortality rate (F) of *S. pharaonis* and *L. duvaucelii* was more than $F_{0.1}$.
- The landing of brown mussel (*Perna indica*) at Vizhinjam was 492 t with peak landings during September-October. The exploitation rate of this species was 0.47.

Landigs of *Octopus* spp. at Cochin Fisheries Harbour

Marine fish landings in Lakshadweep

- The estimated total fish catch from Lakshadweep in 2009 was 10,189 t, of which tunas constituted 81.1% (8,264 t) and other fishes formed 18.9% (1,925 t). The tuna contribution has shown an increase

Estimated landings (t) of major resources along Kerala coast

Resource	2008	2009
Oil sardine	231636	167428
Indian mackerel	57843	56643
Penaeid prawns	42369	45112
Carangids	31510	37721
Threadfin breams	30554	32542
Cephalopods	46199	25478
Tunnies	20188	17881
Soles	13258	12541
Ribbonfishes	10699	6031
Stolephorus spp.	67793	26665
Lizardfishes	10521	11416
Seerfishes	10921	4528
Lesser sardines	14368	3878
Non-penaeid prawns	3932	3754

Landings of squids at Cochin Fisheries Harbour

of 4.5% compared to 2008. This was mainly due to the increase of 13.8% in pole and line catches at Minicoy and drift gillnet catches (+98.3%) at Androth. However, the pole and line catches at Agatti showed a decline of 21.6%.

- In the total fish catch, the highest contributor (89%) was pole and line (PL) followed by troll line (TL) and drift gillnet (DGN) with 4.7% and 2.2%, respectively. Encircling gillnet (EGN) and hand line (HL) contributed 2% each. PL was the most important gear for the tuna fishery with a contribution of 94.8% followed by TL, DGN and HL, contributing 3.3%, 1.66% and 0.28% respectively. Among tunas, *K. pelamis* (80%) was the most important species landed.
- At Androth, DGN yielded very good catches of medium sized yellowfin tunas in September and October (23.7 t). At Minicoy, hand line fishing yielded large sized yellow fins having an average weight of 70 kg in January (48.2 t). Prices of the smoke-dried Lakshadweep *mas* collapsed due to the competition from the mainland *mas* and the Lakshadweep administration announced a support price of Rs. 240/kg for Lakshadweep *mas*.

PROJECT CODE PEL/IDP/02
PROJECT TITLE **Management advisories for sustaining marine fisheries of Karnataka and Goa**
SCIENTISTS **A.P. Dineshbabu,** Geetha Sasikumar, P.S. Swathi Lekshmi and K.G. Mini.
CENTRES Mangalore and Karwar

- In 2009, the estimated marine fish landings of Karnataka was 2,77,553 t which showed 15.9% decrease compared to 3,30,060 t recorded in 2008. In Goa, the annual catch being 71,391 t showed 35.4% decrease compared to 1,10,508 t recorded in 2008.
- In Karnataka, major gears contributing to the catch are multiday trawl, MDT (45.0%, CPH: 46.5 kg), purse seine (27.0%, CPUE: 1,752.4 kg), single day trawl, SDT (11.1%, CPH 45.9 kg), gillnets (9.3%) and 'other gears' (7.6%).
- The annual production by purse seine (75,028 t) formed 27% of the total marine production of the state. Overall, the purse seine fishery showed a decreasing trend in catch (15.4%), effort (0.6%) and CPUE (14.9%).
- Mechanised vessels of 9-9.5 m over-all length (OAL) engage daily fishing trips of trawling in the inshore waters. In 2009, landings by SDF were of 30,853 t, with a catch rate of 45.9 kg h^{-1} contributing 11.2% to the marine fish production of the state. Shrimps constituted 16.6% and crabs 2.6%. Finfishes comprising soles (11%), silver bellies (6.2%), croakers (4.4%) carangids (4.1%) and *Thryssa* spp. (3.2%) were the commercially important groups.
- The fish landing by multiday trawls was 1, 24,922 t, with a catch rate of 46.5 kg h^{-1} contributing 45% to the marine fish production of the state. The major catch consists of threadfin breams (24.4%), lizard fishes (12.9%), perches (5.3%), ribbon fishes (7.7%), mackerel (5.3%), cephalopods (10.0%) and penaeid prawns (4.6%).

- Gillnet landing was 25,691 t in 2009 contributing 9.3% of the total catch of Karnataka. Canoes with outboard engines are used for operating gillnets of small mesh sizes for the capture of fishes mainly Indian mackerel, penaeid prawns, croakers, *Thryssa* spp., oil sardine, carangids etc. and big mesh size to capture seerfishes, tunas and sharks.
- Other gears such as *yendi*, *kairampani* (shore seines), cast net *etc.* landed 21,059 t forming about 7.6% of the total marine fish production of the state. The major fish varieties landed by these gears include oil sardine, Indian mackerel, croakers, carangids, other clupeoids, silver bellies, shrimps and crabs.
- Purse seine fishing is very popular in Goa; the annual production by the gear (57,806 t) was forming 81% of the total marine production of the state. Overall, the catch and effort showed decreasing trend (27.4%) and the CPUE was 0.02%.
- Mechanised vessels of 9-9.5 m over-all-length (OAL) engage daily fishing trips of trawling in the inshore waters. In 2009, landing by SDF was 3,028 t, with a catch rate of 16.5 kg h^{-1} contributing 4.2% to the marine fish production of the state. Shrimps constituted 42.4% and crabs 9.1%. Finfishes comprising soles (24.1%), croakers (8.3%), lizard fishes (4.2%) and *Thryssa* spp. (2.6%) were the commercially important groups.
- The landings by multiday trawls were 7,588 t, with a catch rate of 24.6 kg h^{-1} contributing 10.6% to the marine fish production of the state. The major catch consists of threadfin breams (46.4%), ribbon fishes (6.1%), rock cods (4.6%), lizard fishes (4.1%), cephalopods (12.2%) and penaeid prawns (10.1%).
- Gillnet landings was 732 t in 2009 contributing 1% of the total catches of Goa. Canoes with outboard engines are used for operating gillnets of different mesh sizes for the capture of fishes mainly for Indian mackerel, penaeid prawns, croakers, *Thryssa* spp., oil sardine, carangids *etc*.
- Among demersal resources, threadfin breams were the dominant group represented by *N. mesoprion* (70%) and *N. japonicus* (30%). Their mean size in the fishery was 11.9 cm and 14.2 cm as against the L_m of 17.2 cm and 18.8 cm respectively.
- The whitefish fishery was supported by fishes of mean size 15.2 cm and the estimated L_m was 13.2 cm.
- Out of five species in the sole fishery, *C. macrostomus* was the dominant species with a mean size of 13.1 cm as against the L_m of 11.5 cm.
- Among elasmobranch resources, sharks were the dominant group forming 79% followed by rays (12.3%) and skates (8.7%). Shark fishery was represented by five species and *Igo omanensis* was the major species in trawl and *C. limbatus* in drift gillnet. Among rays, *Himantura bleekeri* was the dominant species followed by *Mobula mobular*.

- Seerfish landing showed a decreasing trend (29.6%) in Karnataka, whereas, an increasing trend (161.3%) in Goa when compared with 2008.
- Ribbonfish landing in 2009 showed a decreasing trend (48%) in Karnataka and Goa (42.1%).
- Oil sardine landing in 2009 showed a decreasing trend in Karnataka (29.4%) and in Goa (43.1%).
- Mackerel landing showed an increasing trend (35.3%) in Karnataka and a decreasing trend (50.3%) in Goa.
- Threadfin breams showed a decreasing trend in Karnataka (11.0%) and Goa (41.2%).
- Whitefish landing showed 43.0% increase in Karnataka and 13.5% decrease in Goa.
- Elasmobranch landing showed an increasing trend in Karnataka (36.7%) and in Goa (6.4%).
- Shrimp landings showed 9% increase in Karnataka and 53.5% decrease in Goa.
- Crab landing in 2009 showed 2% decrease in Karnataka and 16.8% decrease in Goa.
- Cephalopod landing showed a decrease of 47.7% in Karnataka and 46.5% in Goa.

Motorised craft landing centre in Goa

Major marine fish catch (t), percentage composition, trend and its value in Karnataka during 2009

Species	Catch (t) 2009	% in total catch	Catch (t) 2008	Trend (%) (+/-)	Value (Rs. in lakhs)
Oil sardine	57,223	20.6	80,998	-29.4	4,557.84
Lesser sardines	5,915	2.1	7,375	-19.8	354.9
Stolephorus spp.	6,915	2.5	2,836	143.8	1,383.0
Carangids	15,132	5.5	18,151	-16.6	2,258.3
Mackerel	38,683	13.9	28,587	35.3	13,539.05
Ribbon fishes	9,920	3.6	19,077	-48.0	2,480.0
Seer fish	4,407	1.6	6,262	-29.6	4,894.6
Tunas and billfishes	689	0.2	2,717	-74.6	198.2
Threadfin breams	30,770	11.1	34,564	-11.0	9,231.0
White fish	3,484	1.3	2,437	43.0	1,742
Flatfishes	6,020	2.2	3,541	70.0	1,806
Silverbellies	4,559	1.6	4,725	-3.5	227.95
Elasmobranchs	1,393	0.5	1,019	36.7	672.1
Pomfrets	348	0.1	542	-35.8	417.6
Shrimps	11,550	4.2	10,593	9.0	13,857.2
Crabs	1,791	0.6	1828	-2.0	716.4
Squilla	14,838	5.3	13,177	12.6	445.14
Cephalopods	12,527	4.5	23,931	-47.7	9,690.9
Others	51,389	18.5	67,700	-24.1	7396.82
Total	**2,77,553**		**3,30,060**	**-15.9**	**7,5869.0**

Major marine fish catch (t), percentage composition, trend and its value in Goa during 2009

Species	Catch 2009	% in total catch	Catch 2008	Trend (%) (+/-)	Value (Rs. in lakhs)
Oil sardine	27,930	39.1	49,123	-43.1	2,234.4
Lesser sardines	3,710	5.2	4,015	-7.6	222.6
Stolephorus spp.	63	0.1	0		12.6
Carangids	6,602	9.2	6,644	-0.6	1,158.8
Mackerel	11,795	16.5	23,735	-50.3	4,128.25
Ribbon fishes	841	1.2	1,452	-42.1	210.25
Seer fish	1,463	2.0	560	161.3	1,754.1
Tunas and billfishes	1,848	2.6	2,276	-18.8	462.0
Threadfin breams	3,539	5.0	6,021	-41.2	1,061.7
White fish	166	0.2	192	-13.5	83.0
Flatfish	873	1.2	211	313.7	261.9
Silverbellies	1,266	1.8	822	54.0	63.3
Pomfrets	23	0.03	83	-72.3	27.6
Elasmobranchs	50	0.1	47	6.4	25.0
Shrimps	2,095	2.9	4,508	-53.5	2,514
Crabs	417	0.6	501	-16.8	166.8
Squilla	249	0.3	677	-63.2	7.47
Cephalopods	974	1.4	1,310	-25.6	608.25
Others	7,487	10.5	8,331	-10.1	1,624.0
Total	**71,391**		**1,10,508**	**-35.4**	**16,626.0**

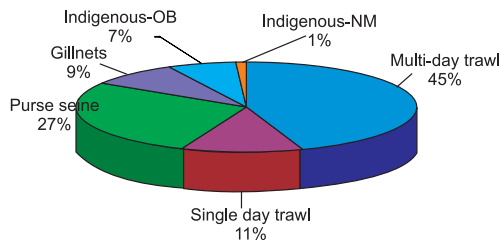
- Among the demersal species *N. japonicus, N. mesoprion*, *L. lactarius* and *C. macrostomus* were found to be exploited at a higher level than optimum.
- Landing of shrimps in 2009 was estimated at 11,550 t in Karnataka and 2,095 t in Goa. Trawl was the major gear.
- The landing of shrimps showed 9% increase in Karnataka and 53.5% reduction in Goa. Among 11 species, *M. monoceros* (40%) was the most dominant species in Karnataka. Landing of *M. monoceros* was estimated as 4,150 t in Karnataka and 277 t in Goa.
- Crab landing in 2009 was estimated as 1,791 t in Karnataka and 417 t in Goa. The production showed 2% decrease in Karnataka and 16.8% decrease in Goa.
- Out of the three edible species of crabs, *Portunus sanguinolentus* (49%) was the most dominant species. *P. sanguinolentus* landing in 2009 was estimated at 1,127 t in Karnataka and 158 t in Goa. Landing showed an increase of 133% in Karnataka and 10% in Goa.
- The cephalopod fishery of Karnataka was supported by the squid, *Loligo duvauceli*, cuttlefish, *Sepia pharaonis* and octopus, *Octopus membraneous*. *L. duvauceli* and *S. pharaonis* were the dominant species in Goa. The production from Karnataka registered 47.7% decrease while 25.6% decrease was noticed in Goa.
- The size range of *S. pharaonis* in the fishery was 20 to 390 mm with a mean size of 168 mm. *L. duvauceli* ranged from 20 to 350 mm with a mean size of 126 mm.

S. choprai landing in Mangalore Fisheries Harbour

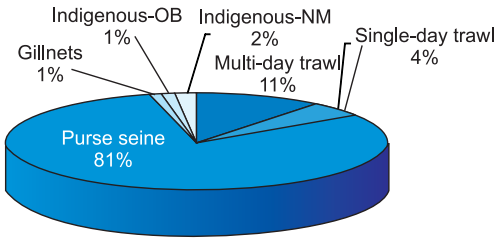
By *FiSAT* based catch curve method, it was estimated that out of 24 species studied, 19 species were exploited above optimum (E = 0.6) level in 2009.

Status of exploitation of species along Karnataka Coast in 2009

Below optimum level (E)		Optimum level (E)		Above optimum level (E)	
A. thazard	0.44	*P. stylifera*	0.57	*R. kanagurta*	0.76
P. sanguinolentus	0.43	*M. monoceros*	0.55	*T. lepturus*	0.70
		S. pharaonis	0.52	*S. commerson*	0.75
				E. affinis	0.63
				M. cordyla	0.60
				D. russelli	0.76
				E. devisi	0.82
				S. waitei	0.70
				N. japonicus	0.74
				N. mesoprion	0.61
				S. longiceps	0.67
				C. macrostomus	0.72
				L. lactarius	0.60
				M. dobsoni	0.64
				S. choprai	0.63
				P. pelagicus	0.62
				C. feriatus	0.66
				L. duvaucelli	0.63
				S. elliptica	0.71



Gearwise landings in Karnataka in 2009

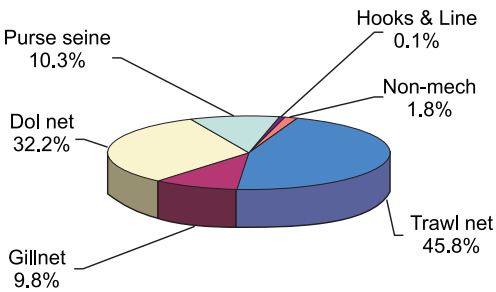


Gearwise marine fish landings (%) in Goa in 2009

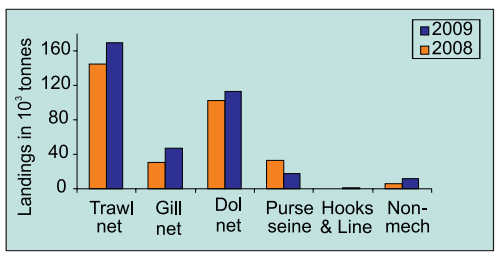
Socio-economic study of fisheries sector of Karnataka

- A sample of 35 migrant labourers from the loading/unloading sector was selected for the study on the migrant labourers in the marine fisheries sector. The socio-economic characteristics of these labourers were studied.
- The findings revealed that, 54.2% were young, 82.8% were illiterate, 71.4% had joint families and family labour was utilised, to accentuate their income. The social participation *i.e.*, membership in cooperative societies, self-help groups and local bodies was nil.
- The peak period of employment for these migrant labourers was during October-December with an average of 25 days of employment in a month during this period. The average wage rate of male labourers during the peak season was Rs. 300/day for 14 hours of work from 5 am to 7 pm, and for female labourers it was Rs 100-200/day for 13 hours of work from 5 am to 6 pm. The medium season of employment was during August-November and the average wage rate during this season was Rs. 100-150 for male labourers and for females it was Rs. 50-60.

PROJECT CODE CF/IDP/01
PROJECT TITLE **Management advisories for sustaining marine fisheries of Maharashtra**
SCIENTISTS **V.D. Deshmukh,** S.G. Raje, Somy Kuriakose and V.P. Vipinkumar
CENTRES Mumbai and Kochi



Gearwise composition of fish landings in Maharashtra

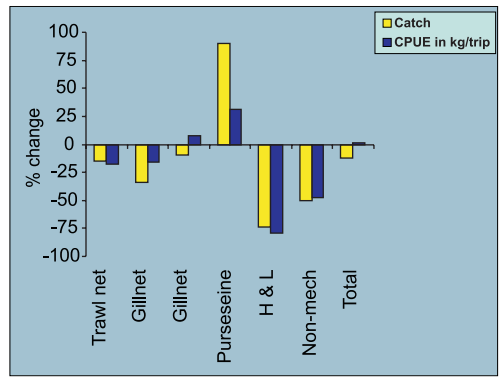


Gearwise comparison of landings in Maharashtra in 2008 and 2009

- The estimated marine fish landings in Maharashtra in 2009 was 3.16 lakh t which recorded 11.9% decline as compared to 3.59 lakh t in 2008. Shrimp trawl was the major gear that contributed 1.45 lakh t (45.8%) followed by dol nets with 1.02 lakh t (32.2%), purse seines 32,436 t (10.3%), gillnets 31,043t (9.8%), hooks and lines 298 t (0.1%) and other non-mechanized gears 5,679 t (1.80%).
- During the year, except for purse seine, landings by all the gears declined when compared to 2008. The purse seines recorded 90% increase in catch and 31% increase in catch per trip. The fishing effort by trawl nets, dol nets, gillnets and hooks and lines declined while the purse seines recorded an increase.
- In the state, non-penaeid prawns (19.5%), penaeid prawns (12.4%), croakers (8.3%), Bombayduck (6.5%) and clupeids (5.1%) formed the major components of the landings.
- When compared to 2008, the catch of seerfishes (-53%), eels (-51%), elasmobranchs (-49%), Bombayduck (-22%), lobsters (-20%), cephalopods (-19%), ribbonfishes (-15%), anchovy (-12%), penaeid prawns (-16%) and non-penaeid prawns (-13%) showed significant decline. But, silverbellies (382%), mackerel (54%), stomatopods (31%), rock cods and perches (22%), catfishes (20%), lizard fishes (21%) and threadfin breams (11%) showed increased landings during the year. Revival of big jawed jumper (*Lactarius lactarius*) and red snappers was noteworthy in the year.
- **Trawl fishery:** Shrimp trawl was the major gear that contributed 1.45 lakh t (45.8%) to the total marine fish landings. Owing to low catch the trawling effort declined to 4.95 h against 6.23 h in 2008 showing 21% reduction. Among the trawlers, multiday boats

contributed 1.2 lakh t (83%) while single day trawlers 0.24 lakh t (17%) with catch rates of 30.3 kg h^{-1} and 24.7 kg h^{-1} respectively. Penaeid prawns (19.3%), croakers (13.4%), threadfin breams (12.3%), ribbonfishes (7.6%) and cephalopods (5.1%) formed 57.7% of the trawl catch. Catch of *L. lactarius* showed remarkable improvement: 2,429 t as compared to 651 t in 2008.

- **'Dol' net fishery:** The 'dol' nets landed 1.01 lakh t of fish by expending 4.18 lakh boat-trips at the catch rate of 41.0 kg h^{-1}. When compared to 2008, the number of boat trips declined by 16%, the catch by 9.5% but the catch rate improved by 19.7%. Major components of the 'dol' net fishery were non-penaeid prawns (54.0%), Bombayduck (14.7%), penaeid prawns (9.6%), golden anchovy (5%) silver pomfret (3.6%) and croakers (1.9%).
- **Gillnet fishery:** The gillnets of varying mesh sizes (from 20-140 mm mesh) and dimensions together landed 31,043 t of fish contributing 9.8% to the total fish landed in the state. When compared to 2008, the number of boat trips, declined by 21.5% while catch rate per trip came down by 16%. Major components of the gillnet fishery were clupeids (16.7%), tuna and bill fishes (15.6%), croakers (12.0%) seer fishes (9.7%), catfishes (9.5%), carangids (9.5%) and elasmobranchs (7.1%). The mackerel and pomfrets (4.1% each) formed less than 5% of the total gillnet landings.
- **Purseseine fishery:** Purse seiners operated mainly from Ratnagiri and Mumbai, witnessed good fishing season from September to December. They landed 32,436 t of fish by the operation of 10,849 trips at the catch rate of 2,990 kg $trip^{-1}$. Major components of the purse seines were Indian mackerel (25.8%), catfishes (24%), horse mackerel (15.7%) and tuna and bill fishes (10.9%). The catch of snapper *Lutjanus johnii* in Mumbai was quite unusual for purse seines. The sardines which formed 28.3% of the catch in 2008 formed only 3.1% in 2009. When compared to 2008, the catch almost doubled (89.7%) with concomitant increase in trips by 19% and increase in catch rate by 31%.
- **Hooks and line fishery:** The hooks and line fishery dwindled with only 298 t recording 74% decline when compared to 1,145 t landings in 2008. The catch rate declined to 33.4 kg $trip^{-1}$ from 161.4 kg $trip^{-1}$ during last year. Large sized croakers (Ghol and Koth) were the major components of the fishery followed by catfishes.
- **Non-mechanized fishery:** The fishery by inshore bag nets, gillnets and shore seines recorded 5,679 t contributing 1.8% to the total marine fish landings in the state. When compared to 2008, the catch recorded 12% decline with marginal decline in catch rate by 1.6%. Hand picked bivalves (47%) were the major constituent followed by non-penaeid prawns (30%), sardines (9%), penaeid prawns (3%) and mackerel (2%).
- Analysis of past fishery data showed that the long term potential yield (LTPY) for Maharashtra is 5.18 lakh t against annual average (2006-2008) catch of 3.52 lakh t. Based on LTPY for demersal, large and small pelagic resources, the optimum fleet size has been estimated at 8,783 fishing boats against the present fleet size of 23,508 boats registered in the state. The analysis pointed out gross overcapacity in the fishing fleet and therefore, fish famine like situation is observed at individual boat level due to poor catch rate.



Gearwise increase/decrease in landings in Maharashtra


Squid jigging boats at Ratnagiri

PROJECT CODE	DEM/IDP/02
PROJECT TITLE	**Development of management advisories for sustaining marine fisheries of Gujarat**
SCIENTISTS	**Subhadeep Ghosh,** Gulshad Mohammed, R. Thangavelu and T.M. Najmudeen
CENTRES	Veraval and Kochi

Emergence of fishery for the unicorn leather jacket *Aluterus monoceros* (Linnaeus, 1758) at Veraval

Catch between January and August 2009 from trawlers: 41.9 t

Length-weight relationship: log W = -1.50 + 2.694 log L (r = 0.86)

Sex ratio: 1:1.05.

Females attained sexual maturity at 50.2 cm total length.

Major food items were benthic invertebrates, cnidarians and worms, zooplankton dominated by copepods; nekton dominated by *Acetes* spp. and clupeid juveniles.

von Bertalanffy growth equation: $L_t = 63.53 [1 - e^{-0.22 (t + 0.077)}]$.

- The estimated annual landings of Gujarat was 5,07,597 t in 2009, which is 10% higher than that of 2008.
- The maximum landings was that of non-penaeid prawns (15.7%) followed by sciaenids (10.1%), ribbonfishes (9.2%) and Bombayduck (7.8%).
- Gujarat contributed 16% to the all-India landings. The following groups/ species contributed significantly (>30%) to the all-India landings: *Thunnus tonggol* (91.4%), crabs (35.5%), Bombayduck (38.5%), non-penaeid prawns (44.8%), catfishes (37.6%), threadfins (36.5%), ribbonfishes (32.1%), cuttlefishes (37.2%), and squids (32.8%).
- The estimated catch of Bombayduck by dol nets from the inshore grounds of Nawabunder, Rajpara and Jaffrabad was 19,776 t (20.28 % of the dol net catches) with the catch rate of 327.6 kg unit^{-1}.

Biological characteristics and stock assessment

- Biological characteristics and stock assessments were studied for several species of pelagic finfishes. The annual growth coefficient for different species ranged from 0.22 to 0.97. The exploitation ratio was between 0.18 and 0.52. As the ratio was below 0.5 for most of the species, the exploitation of pelagic stocks appears to be under control. This is confirmed from the comparison of Annual Stock and Standing Stock Biomass (SSB) with Annual Yield (AY). The SSB and AY were 7668 t and 5444 t, respectively for *Harpadon nehereus*; 1480 t and 977 t *Coilia dussumieri*; 391 t and 125 t for the hilsa *Ilisha megaloptera*; 655 t and 380 t for *Rastrelliger kanagurta*; 63230 t and 22763 t for *Trichiurus lepturus*; and 986 t and 503 t for *Katsuwonus pelamis*.
- The diet of all the 15 species of pelagic fishes studied consisted of *Acetes* spp. Squilla and juveniles of a variety of commercially important fish groups were also found in the diet.
- The annual growth coefficient for five species of demersal fish ranged from 0.11 to 0.99. The exploitation ratio ranged from 0.41 to 0.56. Exploitation ratio was higher for demersal stocks than pelagic stocks exploited off Veraval. As the ratios for several demersal species are closer to 0.5, further increase in exploitation may not be advisable. The SSB was lower than the AY in the case of the sciaenid *Otolithes cuvieri* (SSB: 2910 t; AY: 5035) and the pomfret, *Pampus argenteus* (SSB: 196 t; AY: 318 t).

Stock assessment of some important pelagic resources landed at Veraval

Species	Annual yield (t)	Annual stock (t)	Standing biomass (t)	MSY (t)
Harpadon nehereus	5444	15601.19	7667.61	6287.44
Coilia dussumieri	976.6	3493.43	1479.70	1524.09
Scomberomorus guttatus	149	386.67	144.66	176.49
Ilisha megaloptera	125.2	825.70	391.25	340.39
Rastrelliger kanagurta	380	1382.69	655.17	570.00
Auxis thazard	82.3	418.04	195.95	173.42
Katsuwonus pelamis	503	1626.23	986.27	542.45
Trichiurus lepturus	22763	92659.02	63230.56	25924.53

Stock assessment of some important demersal resources landed at Veraval

Species	Annual Yield (t)	Annual Stock (t)	Standing Biomass (t)	MSY (t)
Nemipterus japonicus	6884	18863	9696	7369
Otolithes cuvieri	5035	9448	2910	4511
Johnius glaucus	4006	15048	9316	4891
Saurida undosquamis	1308.0	6811	5031	1610
Pampus argenteus	318	678	196	327

- The fecundity of *Caranx kalla, Harpadon nehereus, Coilia dussumieri* and *Euthynnus affinis* were 1337, 349, 225 and 209 per g body weight, respectively.

PROJECT CODE DEM/IDP/01

PROJECT TITLE **Management advisories for sustaining marine fisheries of Tamil Nadu and Puducherry**

SCIENTISTS **P.U. Zacharia,** V. Kripa, K.K. Joshi, M. Rajamani, V. Venkatesan, G. Mohanraj, H. Mohamed Kasim, Shoba Joe Kizhakudan, Sathianarayana Sethi, T.V. Sathianandan and K.N. Saleela

CENTRES Tuticorin, Chennai and Mandapam

- The estimated marine fish production from Tamil Nadu in 2009 was 4,81,783 t, showing an increase of 16.5 % from that of previous year. Pelagics formed 51.4%, demersals 29.3%, crustaceans 7.2% and molluscs 4.2% of the total landings. The increase in landings was mainly due to the increase of 52,259 t of pelagic landings (38.3%). The landings of demersals increased by only 5,041 t (2.6%) compared to previous year.
- Tamil Nadu contributed 15.2% to the total marine fish production of India and stood third in total marine fish landings
- The estimated marine fish landings in Puducherry in 2009 was 13,746 t, which is 8.2% lesser than the previous year. Total demersal landings were 6,896 t which is 31.7% of the total landings in 2009. Pelagic landings contributed 50.2% to the total marine fish landings in Puducherry.
- The most productive period for Tamil Nadu and Puducherry was the 3rd quarter (July-September) whereas the second quarter (April-June) recorded the lowest catches (20.7%).

Skipjack tuna arranged for auction at Tharuvaikuam

Pelagic fish resources

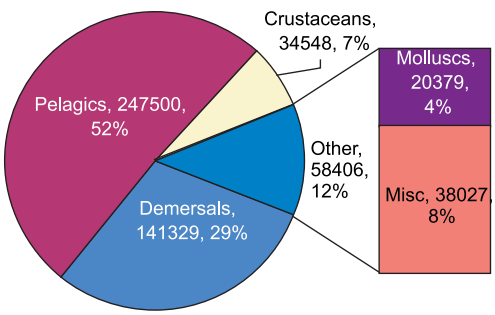
- Virtual population analysis was carried out for *Sardinella gibbosa* at Tuticorin. The estimated parameters are: L_∞=185 mm, K=1.15 year^{-1} and M=2.335. The total mortality Z varied from 2.335 at 115 mm to 4.67 at 180 mm. Fishing mortality F was 2.33 at 180 mm. Spawning stock biomass contributed 45.1% to the standing stock biomass. The VPA parameters of *S. longiceps* were L_∞=225 mm, K=1.55 year^{-1} and M=2.55. Total mortality Z varied from 2.55 at 135 mm to 5.1 at 225 mm. The F was 2.55 at 225 mm. Spawning stock biomass formed 53.9% of the standing stock biomass.
- Population parameters of *Rastrelliger kanagurta* off Tuticorin were: L_∞ =280 mm, K=1.3 year^{-1} and M =2.240. Z varied from 2.24 at 190 mm to 4.48 at 280 mm, F was 2.24 at 280 mm. Spawning stock biomass formed 88.9% of standing stock biomass.

Grouper (Serranid) caught by hooks and line at Threspuram

- Ribbonfish landing in Tamil Nadu was 6,950 t. L_{∞} of *Trichiurus lepturus* was estimated as 1000 mm, K =1.5 year^{-1} and M =1.660. Z varied from 1.66 at 500 mm to 3.22 at 900 mm and F was 3.3 at 1000 mm. The spawning stock biomass formed 76.3% of standing stock biomass.
- Anchovy landings in 2009 in Tamil Nadu was 10,434 t mainly caught by artisanal gears and trawl. Virtual population parameters of *Stolephorus indicus* were: L_{∞}=160 mm, K=0.9 year^{-1} and M=2.12. The total mortality Z varied from 2.12 at 105 mm to 4.24 at 160 mm. The F was 2.12 at 160 mm. Spawning stock biomass formed 43.7% of the standing stock biomass.
- Seerfish was caught mainly by drift gillnetters. The production was 7,945 t against 5,474 t landed in the previous year.

Demersal fish resources

- Total elasmobranch landings was 14,010 t, of which sharks formed 18.9%, skates 11.5% and rays 69.6%. Annual landings at Chennai was 921 t by trawl net, 1,157 t by mechanized gillnet, and 23.5 t by hook and line. At Mandapam, the estimated trawl landing of rays was 1,492 t at a catch rate of 0.82 kg h^{-1}. The elasmobranch landing in trawl at Tuticorin was 990 t of which rays formed 43%, skates 38% and sharks 18%. Heavy landing of rays in trawl was noticed in July.
- Annual landing of sciaenids was 7,577 t mainly caught by trawl net. Population studies of *Pennahia macrophthalmus* at Mandapam indicated that the total mortality coefficient (Z) was 0.91 and exploitation rate (E) was 0.29. The standing stock and spawning stock biomass were 27949.3 and 6558.5 t respectively. Sex ratio was 1:1 and 84% of the fish were in mature condition.
- Goatfish landing decreased from 7,364 t to 6565 t. Stock estimate studies carried out for *Upeneus sundaicus* from Gulf of Mannar indicates that the stock is exploited above the optimum level (E=0.65). The spawning stock biomass formed only 0.22% of standing stock biomass.



Catch composition in Tamil Nadu in 2009

- Lizardfish landings showed substantial increase from 2,172 t to 7,007 t in 2009. Five species were landed and *Saurida tumbil* dominated by 63.8% and other species were *S. undosquamis, S. micropectoralis, S. longimanus* and *Trachinocephalus myops.*
- Silverbellies catch by all gears decreased from 43,989 t to 38,843 t. The present catch recorded 24.39% decrease over four years average catch of 24137.5 t. VPA studies of *Leiognathus jonesi* at Mandapam indicate that stocks are still continued to be subjected to heavy fishing pressure (E=0.71, E=0.82).
- Perches were landed mainly by trawlers. The landing showed an increase from 34,212 t in 2008 to 44,175 t in 2009. Lethrinids formed 38.7% of perch production followed by threadfin breams (18.7%), snappers, 3217 t (7.3%) and groupers (3.3%). Stock assessment studies on *Epinephelus tauvina* indicated that this species is exploited above optimum level in trawls at Tuticorin.

- At Chennai, threadfin bream catch increased from 1,322 t to 2,075 t. Growth and mortality parameters of *Nemipterus mesoprion* were worked out. The spawning stock biomass was 79% of the standing stock biomass. Threadfin bream landing was 1,197 t at Tuticorin Fishing Harbour at a CPH of 4.748 kg forming 3.6% of the total trawl catch.

Crustacean resources

- The total production of crustaceans was 34,538 t out of which shrimp landings contributed 19,167 t. At Mandapam, *Penaeus semisulcatus* was the dominant species throughout the year with annual composition of 87.1% followed by *Metapenaeus stridulans.* The exploitation rate of *P. semisulcatus* was high indicating exploitation above optimum for males and females. At Tuticorin also, *P. semsulcatus* was dominant (34% of prawn landings).
- Crab landing was 12,342 t. The landing of crabs at Mandapam was 609 t mainly supported by *Portunus pelagicus* (86.4%). *P. sanguinolentus*, *Charybdis natator* and *C. feriatus* also landed in small quantities. At Tharuvaikulam, the crab landings were 296 t at CPUE of 37.8 kg. Seven species were seen in the catch, of which *P. sanguinolentus* dominated owing to fishing in deeper waters. Females dominated in most of the months and berried females were more in December.
- Lobster production was 274 t. Lobster fishing at Chinnamuttam was carried out exclusively by bottom-set gillnets (BSGN) engaged by catamaran and canoes. The estimated landing was 652 kg at CPUE of 0.66 kg unit^{-1}. At Kadipatanam the lobster fishing by traps landed 1.7 t and the fishery was represented by two species of which *Panulirus homarus* contributed 88.2% and *P. ornatus,* 11.8%. At Colachel, 6998 units of BSGN operated exclusively for *P. homarus* and maximum catch was recorded in November. Fishery was formed by 130-205 mm sized males and 197-218 mm sized females. The price of live lobsters at landing centre varied form Rs. 400 to 1300/kg.

Molluscan resources

- Cephalopod landings increased marginally to 18,791 t. Squids formed 56.6%, cuttlefishes 39.2% and octopus 4.1% of the cephalopod landings. At Chennai Fisheries Harbour, 1532.4 t of cephalopods were landed by trawlers. Cuttlefishes formed the major quantity (67.6%) followed by squids (25.3%) and Octopus (7.1%). Cephalopod catches of Chennai Fisheries Harbour consisted of eleven species *viz*., *Sepia pharaonis* (24.7%), *S. aculeata* (13.3%), *S. prashadi* (8.5%), *S. brevimana* (9.0%), *Sepiella inermis* (12.1%), *Sepioteuthis lessoniana* (1.7%), *Loligo duvauceli* (10.5%), *L. uyii* (3.2%), *Doryteuthis sibogae* (9.9%), *Octopus dollfusi* (3.8%) and *Cistopus indicus* (3.3%). Biology of *D. sibogae* was studied. The exploitation rate was 0.5.
- At Tuticorin Fisheries Harbour, a total of 94.6 t of cephalopods consisting of *Sepia pharaonis* (65.8 t), *S. lessoniana* (25.2 t), *D. sibogae* (2.2 t) and one species of *Octopus* (1.5 t) were landed. The spawning stock biomass of *S. aculeata* was 62% of the standing stock biomass and the MSY was estimated as 848 t against the present catch of 701 t.

Rare species of crab *Ranina ranina* landed at Tuticorin

Chinnamuttom landing centre

Landings of undersized chanks at Rameswaram

- Landings of gastropods showed remarkable increase from 791 t in 2008 to 1,542 t. About 20 t of gastropods were landed by trawlers. The catch consisted of 21 species, of which *Hemifusus fugilinus* (25.7%) was dominant and *Ficus ficus* formed 8.5%. Total chanks landed in Mandapam was 143 t. *Xancus pyrum* var. *acuta* and *obtusa* was monitored from Mandapam, Rameswaram and Pamban. About 21% of the chanks lan\ded was undersized. The trawlers landed 88.8 t of *Hemifusus* gastropod.

Estimates of potential yield (t) made using 1987-2007 landings data and their comparison with the present landings

Group	Potential yield (t)	Present catch (t)	Exploitation status
Sharks	5579	2646	Below optimum
Rays	11781	9759	Below -do-
Lizardfishes	4518	7007	Above -do-
Perches	22523	44175	Above -do-
Goatfishes	6851	6565	Below -do-
Croakers	10367	7577	Below -do-
Silverbellies	38666	38843	Equal -do-
Penaeid prawns	23456	19167	Below -do-
Lobsters	380	274	Below -do-
Crabs	13429	12342	Below -do-
Cephalopods	11455	18791	Above -do-
Demersals	177663	141329	Below -do-
Seerfishes	9211	7942	Below -do-
Tunas	8989	13520	Above -do-
Billfishes	832	838	Above -do-
Barracudas	6802	9554	Above -do-
Large pelagics	25839	31854	Above -do-
Oil sardine	58662	84878	Above -do-
Lesser sardines	45671	46498	Equal -do-
Anchovies	12503	10434	Below -do-
Other clupeids	19951	10708	Below -do-
Ribbonfishes	4514	6950	Above -do-
Carangids	24740	30812	Above -do-
Indian mackerel	18067	37892	Below -do-
Small pelagics total	198794	170410	Below -do-
Total catch	**435479**	**481783**	Above -do-

PROJECT CODE **MF/IDP/01**

PROJECT TITLE **Developing management advisories for sustaining marine fisheries of Andhra Pradesh**

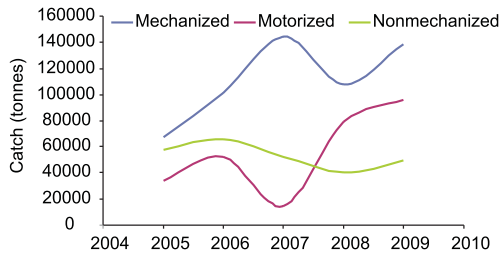
SCIENTISTS **Prathiba Rohit,** G. Maheswarudu, P. Laxmilata, Wilson T. Mathew (CMFRI), R. Reghu and Rajeswari (CIFT)

CENTRES Visakhapatnam and Kochi

- The marine fish landings along Andhra Pradesh coast showed an increasing trend during the past five years with an all time high catch of 2,83,795 t in 2009. The catch in 2009 is 25% more compared to 2008. Pelagic fishes (59.1%) dominated the fishery followed by demersal fishes (24.4%), crustaceans (13.9%), molluscs (1.0%) and others (1.6%).
- A marked increase of 26.3% in the landings of pelagic fishes especially that of seerfish by 2.3 fold, mackerel 49.8%, sardines by 22.8% and

other clupeids by 74.2%, was the contributing factors to the increase in total fish catch of the state. An overall increase in the landings of demersal fishes, crustaceans and molluscs were also observed during the year.

- Among the demersal fishes, the catch of catfish and eels registered an increase of 25.3% and 22.3% respectively during this year as compared to the corresponding period in the previous year.
- The mechanized, motorized and the non-mechanized sectors contributed 48.8%, 33.9% and 17.3% respectively to the catch. An increase of 28.4%, 21.5% and 22.6% respectively was recorded by the three sectors as compared to the previous year.
- Trawls were the major gear contributing 42.7% followed by gillnets (28.0%), seines (14.5%), the hooks and line (4.9%) and other miscellaneous gears (9.9%).
- An overall increase in catch by all the gears was observed during the year. The catch by the hooks and line however recorded the maximum increase this year (2.3 fold increase). The increase in catch by gillnets increased by 40% and that of seines by 31.7%. The catch by trawls increased by 14.3% as compared to the previous year.



Sectorwise landings in Andhra Pradesh during 2004-09

Gear-wise total catch rates of major pelagic resources in Andhra Pradesh

Gear	All fish	Sardines		Mackerel		Ribbonfish	
	C/E (kg)	C/E	+/- %	C/E	+/- %	C/E	+/- %
Mechanized trawl	28.1	0.93	25.56	2.2	5.5	2.4	-31.2
Mechanized seines	550.5	51.6		20.6		0.8	
Motorized seines	681.5	393.1	41.5	127.5	168.3	1.4	164.5
Non-mechanised seines	770.8	327.0	2.62	155.5	463.4	56.7	
Mechanised GN	129.6	26.4	-18.5	9.7	Several fold	3.7	Several fold
Motorized GN	90.9	7.5	20.4	5.9	13.0	2.5	-1.1
Non-mechanised GN	52.7	19.6	-89.4	4.6	-89.4	2.1	-92.0
Mechanised H & L	229.3	91.3		5.3			
Motorized H & L	106.4	0					
Non-mechanized H & L	45.6	0					

- The catch per effort showed variation among the different gears. The catch per hour in trawls declined by 71.9%. The motorized and non-motorized gillnets, and the non-motorized hooks and lines registered a decline of 9.1%, 47.2% and 57.4% respectively in their catch per effort during the year as compared to 2008. Mechanized, motorized and non-motorized seines registered several fold increase during the year. The mechanized gillnets, mechanized and the motorized hooks and lines registered an increase of 29.6%, 129.3% and 6.4% respectively. The increase in CPUE in some of the above mechanized and motorized gears indicated that fishing in deeper waters especially for the large pelagics is on an increase and is productive.
- The major groups supporting the fishery in Andhra Pradesh during the period were sardines (20.7%), penaeid prawns (10.5%), mackerel (9.5%), carangids (5.5%), ribbonfish (5.0%), croakers (4.3%), whitebaits (4.2%), tunas (4.1%) and seerfish (3.6%). While ribbonfish

fishery was supported by a single species, the other groups comprised of several genera and species. Other groups which contributed to the fishery of Andhra Pradesh were pomfrets (3.1%), crabs (2.3%), goatfish (2.2%), and catfish (2.1%). The demersal crustaceans and cephalopods were mainly landed by the trawls whereas the pelagic fishes were landed by gillnets, trawls, seines and hooks and lines.

- Among the pelagic groups studied, ribbonfishes comprised of a single species *Trichiurus lepturus*, sardines composed of the oil sardine *Sardinella longiceps* (46.4%) and lesser sardines composed of *S. fimbriata* (46.0%) and *S. gibbosa* (7.6%). Mackerels were represented by two species, *Rastrelliger kanagurta* (88.4) and *R. faughnii* (11.6%). Tunas were represented by four species - *Thunnus albacares* (39.7%), *Katsuwonus pelamis* (9.7%), *Euthynnus affinis* (46.8%) and *Auxis thazard* (3.7%). *Scomberomorus commerson* (68.1%) and *S. guttatus* (31.9%) were the two species representing the seerfish fishery.

Length range, mean size, sex ratio and length at maturity of demersal finfish, crustacean and cephalopod resources in trawls

Species	Length range (cm)	Means size (cm)	Sex ratio	L_m
N. japonicus	11.5-29.5	18.2	1:0.5	16.8
S. undosquamis	10.5-34.8	21.6	1:2.17	23.0
U. vittatus	8.3-19.8	13.4	1:1	13.8
P. macrophthalmus	95-27.5	19.7	1:1.4	
P. argenteus	11.5-22.5	19.4		
M. monoceros (males)	8.6-20.0	13.5	1:1.5	9.5
M. monoceros (Females)	10.1-21.5	15.7	1:1.5	11.5
M. dobsoni (males)	6.1-10.5	8.35	1:1.2	6.0
M. dobsoni (Females)	5.6-11.0	9.29	1:1.2	7.8
P. sanguinolentus (Males)	8.6-18.0	12.8	1:2	8.0
P. sanguinolentus (Females)	8.6-16.5	11.8	1:2	8.6
L. duvauceli (Males)	4-14	8.9	1:1.1	
L. duvauceli (Females)	4-14	9.2	1:1.1	
S. pharaonis (Males)	8-28	17.8	1:1.4	
S. pharaonis (Females)	9-28	17.9		
S. aculeata (Males)	8-26	12.4	1:1	
S. aculeata (Females)	7-25	13.7		

- Among the demersal fishes studied, the threadfin breams were represented by *Nemipterus japonicus* (58.4%), *N. mesoprion* (22.7%), *N. delagoae* (10.5%), *N. tolu* (4.1%) and *N. luteus* (4.2%). The elasmobranchs were represented by rays (50.3%), sharks (48.7%), and skates (1.0%). Five species of lizardfishes contributed to the fishery. *Saurida undosquamis* (44.1%) was the dominant group followed by *S. tumbil* (28.4%), *S. micropectoralis* (22.4%), and *Trachinocephalus myops* (5.1%). *Upeneus vittatus* (48.3%), *U. sulphureus* (25.6%) and *U. moluccensis* (26%) formed the goatfish fishery of the region. Sciaenids comprised of 12 species. *Otolithes ruber* (22.3%) was the dominant species followed by *Protonibea diacanthus* (18.9%), *Pennahia macroptthalmus* (13.2%), *Nibea maculata* (10.7%), *Johnius carutta* (8.1%), *Johnius belangeri* (8.1%), *Johnius vogleri* (5.8%), *Nibea soldado* (4.7%), *Johnieops macrorhynus* (9.3%), *Kathala axillaris* (2.1%), *Atrobucca nibe* (0.9%) and *Johnius dussumieri* (2.1%).

Yellowfin tuna caught in hooks and line

- Crustaceans were represented by prawns, crabs and lobsters. Among prawns, the penaeids formed 90.8 %. The dominant species in the

fishery were *M. monoceros* (32%), *M. dobsoni* (15%), *S. crassicornis* (31%). Crabs were represented by *Portunus sanguinolentus* (78.1%) and *P. pelagicus* (13.7%), *Charybdis cruciata* (8.2%). The catch of penaeid prawns marginally increased by 24.6% whereas the catch of crabs declined by 51.9%.

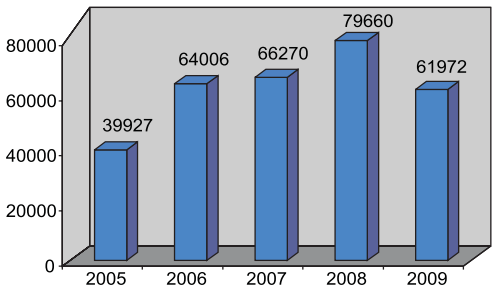
- Cephalopods were represented by cuttlefish (62.5%) and squids (29.2 %). Squids were entirely formed of a single species - *Loligo duvauceli* whereas the cuttlefish catch comprised of *Sepia pharaonis* and *S. aculeata*.
- Stock assessment studies of 16 commercially important species contributing to the fishery of Andhra Pradesh revealed that 13 of them are being exploited at levels higher than the optimum, two species at optimum levels and there is scope to increase production of two species by increasing the effort.

Growth and present exploitation rates of important species in Andhra Pradesh

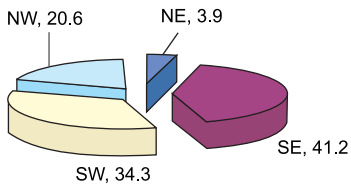
	L_∞ (cm)	K yr^{-1}	Exploitation rate
Sardinella gibbosa	19.13	1.8	Above optimum
Rastrelliger kanagurta	27.9	1.7	Above optimum
Trichiurus lepturus	103.8	0.26	Above optimum
Scomberomorus guttatus	64.22	1.31	Below optimum
Thunnus albacares	240	0.2	Below optimum
Nemipterus japonicus	32.25	0.60	Above optimum
Saurida undosquamis	39.8	0.33	Above optimum
Upeneus vittatus	20.8	0.52	Below optimum
Johnius carutta	29.7	0.32	Above optimum
Otolithes ruber	46.13	0.45	Optimum
Sepia pharaonis	32.7	0.82	Optimum
Loligo duvauceli	23.9	1.35	Above optimum
Metapenaeus monoceros			
male	18.5	2.2	Above optimum
female	22.4	1.78	Above optimum
Metapenaeus dobsoni			
male	11.9	1.4	Above optimum
female	12.5	1.75	Above optimum
Portunus sanguinolentus			
male	23	1.4	Above optimum
female	22	1.3	Above optimum

PROJECT CODE **PEL/IDP/03**
PROJECT TITLE **Strategies for sustaining tuna fisheries along the coast of India**
SCIENTISTS **E.M. Abdussamad,** N.G.K. Pillai, Pratibha Rohit, Shubhadeep Ghosh, K.K. Joshi, K.K. Vijayan and Srinivasa Raghavan.
CENTRES Kochi, Veraval, Tuticorin and Visakhapatnam

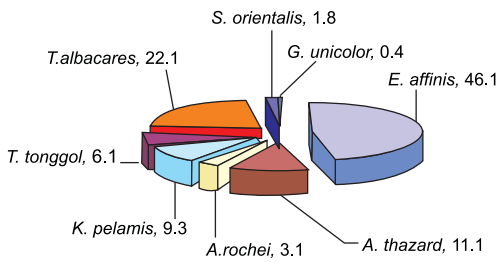
- Tuna landings along Indian coast was estimated at 61,972 t during 2009. During the year, tuna contributed 1.9% to the total marine fish production of the country. Their contribution to the total marine fish catch declined compared to 2.2% of the previous year.
- West coast contributed major share of the production (54.9%). South-east coast contributed 41.2%, followed by south-west (34.3%), north-west (20.6%) and north-east coast (3.9 %).



National tuna production (t) during 2005-'09



Region-wise percentage contribution of tuna in 2009



Species composition (%) in tuna landings in 2009

- Annual growth rate of tuna landings was 5%, in 2005, 60.3% in 2006, 3.5% in 2007 and 20% in 2008. However in 2009 production trend reversed by registering 22.2% decline over the previous years' landings of 79,660 t, despite an increase in total marine fish production.
- Yield and catch rate of tuna species from four zones and in major gears significantly declined during the year. This indicated an over all decline in tuna abundance along both the coasts.
- Tuna along the Indian coast was exploited by a variety of gears, major being gillnets, hooks and lines and purse seines. Major share of the catch (more than 50%) was contributed by gillnets, followed by hooks and lines and purse seine. During the recent past, considerable changes took place all along the mainland coast in the pattern of tuna exploitation. The recent past witnessed increasing demand for tunas from domestic and international markets and as a consequence, effort input increased in distant waters for exploiting oceanic tunas.
- Fishery was supported by eight species; 6 at commercial level and two as incidental catches. Coastal tuna dominated by contributing 57.2 % to the total tuna yield, oceanic 31.8% and neritic 11%. Among the species, *E. affinis* dominated (46.1%) the catch, followed by *T. albacares* (22.1%) and *K. pelamis* (9.3%). Considerable spatial variation in catch composition was also observed during the period. Major share of the *T. albacares* and *E. affinis* catch is from south-east region, *K. pelamis* and *T. tonggol* from north-west coast and *Auxis* spp. from south-west coast.
- Juveniles of *E. affinis, A. thazard* and *S. orientalis* were observed in trawl and gillnet catches at their areas of abundance mainly at Kochi and Tuticorin during May-June. Catches by these gears comprised of immature fishes of 20 to 35 cm size. Young-ones of yellowfin and long tail tuna were observed in gillnet catches along the south-west coast during November-March in appreciable amount.
- Gonad maturity, spawning and fecundity of eight species were studied. All the species except *Gymnosarda unicolor* and *T. tonggol* mature and spawn round the year along the south-west coast. *G. unicolor* was found to mature and spawn during October-March, the period of their peak fishery. *T. albacares* landed along the south-west coast shows full gonadal maturity from 50 cm FL onwards and size at first maturity was estimated as 54.5 cm FL; which is much smaller than the earlier reports from different areas.
- Gene sequencing of seven species for genetic barcoding was carried out and was deposited with the gene bank of National Centre for Biotechnology Information (NCBI).
- Stock assessment indicated that coastal tuna production is very close to MSY level at many centres. More than 85.6% of the coastal tuna potential is being exploited. However, only less than 15% of the oceanic tuna potential is currently exploited and there is considerable scope for enhancing production.

Management options

- Coastal tuna production at intensely exploited areas like south-east and south-west coast almost reached or even crossed optimum level. But on national basis, marginal scope for improvement in production exists. To increase their production, underexploited areas have to be identified and more effort should be concentrated to exploit the resource.
- Effort required to exploit the oceanic tuna resources have to be standardized based on the MSY and exploitation capability of the existing fishing fleets. Accordingly, excess efforts from coastal waters have to be diversified for undertaking oceanic tuna fishing or wherever necessary additional efforts has to be introduced.

Region-wise tuna catch and contribution (%) in 2008 and 2009

Area	Catch (t) 2008	Catch (t) 2009	Catch (%) 2008	Catch (%) 2009	% change
NE	4639	2422	5.8	3.9	-47.8
SE	27286	25527	34.3	41.2	-6.4
SW	25165	21242	31.6	34.3	-15.6
NW	22570	12781	28.3	20.6	-43.4

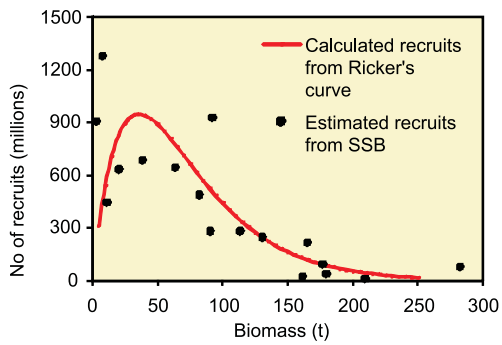
PROJECT CODE CF/RE/03

PROJECT TITLE **Recruitment dynamics of penaeid prawns along Indian coast**

SCIENTISTS **V.D. Deshmukh,** A.P. Dineshbabu, P.T. Sarada, Rekha Devi Chakraborty, Lakshmi Pillai and G. Maheswaradu

CENTRES Mumbai, Mangalore, Calicut, Kochi and Visakhapatanam

- During the year, the data on the fishery and biological characteristics of penaeid prawns for the past 10 years were compiled and re-organized on calendar year basis from important centres at Mumbai, Kochi, Mangalore, Calicut and Visakhapatanam.
- With VBGF growth parameters, size at first maturity and analysis of monthly length frequency distribution of prawns, month-wise number of recruits and biomass of spawning stock (adult and mature females) was estimated by length cohort analysis (LCOHOR).
- The relationship between recruits and spawning stock was estimated considering the data on monthly basis and also the pulses of recruitment and spawning stock peaks with a time lag of 4-5 months between them.
- The monthly estimated number of recruits and the spawning stock biomass of *P. stylifera* revealed a dome shaped Ricker's relationship in the case of stock in Mumbai. The regression of monthly estimated number (R) of recruits (in millions) and the spawning stock biomass Ln(S/R) by Ricker's model gave the following parameters: a = 11.184 ± 0.418; b = 0.0279 ± 0.003 (r^2 = 0.840).
- Similar attempt was made for *M. monoceros*, *P. stylifera* and *M. dobsoni* from Visakhapatanam, Calicut and Cochin waters which also showed better fit by Ricker's model.



SR curve for *P. stylifera* considering spawning round the year

PROJECT CODE	CF/IDP/02
PROJECT TITLE	**Resource damage assessment in marine fisheries: impact of selective fishing of juveniles and bycatch and discards in trawl fisheries**
SCIENTISTS	**E.V. Radhakrishnan,** Subhadeep Ghosh, A.P. Dineshbabu, P.P. Manojkumar, R. Sathiadhas, J. Jayasankar, K. K. Philippose, M. Rajamani, S. Lakshmi Pillai, Shoba Joe Kizhakudan, G. Maheswarudu and Sujitha Thomas
CENTRES	Veraval, Mumbai, Mangalore, Calicut, Kochi, Tuticorin, Mandapam, Chennai and Visakhapatnam

Management measures

- Increase in codend mesh size of trawl nets to 35 mm.
- Popularization of bycatch reduction devises among trawl owners.
- Prohibition of minitrawling, *thallumadi* and *thalluvalai* in coastal nursery areas of shrimps along Kerala, Palk Bay and Gulf of Mannar coasts.

- In 2009, the bycatch, particularly the Low Value Bycatch (LVB) landed and discarded by trawlers was estimated from landing centres at Veraval, Mumbai, Mangalore, Calicut, Cochin, Tuticorin, Mandapam, Chennai and Visakhapatnam centres. The LVB is mostly discarded by multi-day fishing trawlers, except the last day's haul, whereas single day fishing trawlers invariably bring the bycatch to the shore. However, Veraval is an exception where the trawlers bring the entire LVB to the landing centre in a highly decomposed state. The LVB is sorted out and sold for consumption depending upon the quality of the fish and the non-consumable part is dried and used for making poultry feed, fish meal or fertilizer.
- At Veraval an estimated 33,337 t of LVB were landed with a catch rate of 21.9 kg h^{-1}, forming 24.7% of total trawl landings. Maximum landing was in December (4758 t.). An estimated 2269 t of LVB was discarded. The value of LVB landed at Veraval was estimated as Rs. 11.2 crores.
- An estimated 69.3 t of bycatch, with a catch rate of 3.6 kg h^{-1} were landed at Versova, Mumbai forming 23% of total trawl landings. 86 species of marine organisms constituted the bycatch (54 species of fishes, 11 species of crabs, 5 species of cephalopods, 2 species of stomatopods, 8 species of penaeids and 6 species of non-penaeid shrimps).

Composition of Low Value Bycatch (LVB) landed at different centres

Centres	No. of genera/species in LVB	Composition
Veraval	34 genera/species finfishes, 8 genera of crustaceans	*Johnius glaucus* (9.6%), *Apogon* spp. (2.9%), *Otolithes cuvieri* (2.5%), *Trichiurus lepturus* (2.5%), *Acetes* spp. (33.7%), *Oratosquilla nepa* (10.32%)
Mangalore	95 species of finfishes, 20 species of molluscs, 27 species of crustaceans	*Lagocephalus inermis* (13.6%), *Nemipterus* spp. (11.4%), *Saurida* spp. (9.6%), *Sardinella longiceps* (7.7%), *Leiognathus* spp. (7.4%).
Calicut	116 species of finfishes, 24 species of molluscs, 19 species of crustaceans	Threadfin breams (14%), Juveniles of groupers (14%), Lizard fishes (10.6%), Flatheads(10%), *Squilla* spp. (1.3%)
Chennai	53 species of finfishes, 66 species of crustaceans, 13 species of molluscs	Silverbellies (31%), Threadfin breams (14%), Clupeoids (21%), Flatfishes (12%).
Visakhapatnam	60 genera/species of finfishes, 16 genera/species of crustaceans and molluscs	Silverbellies (16.5%), Eels (5.3%), Goatfishes (5.2%), *Oratosquilla* sp. (8.6%), Crabs (10%).

- The study revealed that 100% of all species of fishes landed as bycatch were juveniles.
- An estimated 14,837 t of bycatch was discarded and 12714 t landed by multiday trawlers (MDF) at Mangalore. 47% of the catch of single day fishing trawler's (SDF) landing was constituted by trash, which was dominated by stomatopods. Maximum landing was in January. 153 genera/species constituted the bycatch and *Lagocephalus inermis* (13.6%) was the major contributor to the trash.
- Juveniles of commercially important fishes form a substantial portion of the bycatch and an estimated 6600 t of juveniles of *Nemipterus* spp. (35% of trawl landing) was landed. The entire *Scomberomorus commerson* landed (248 t) were juveniles. The estimated economic loss due to harvesting of juvenile *Nemipterus* spp. was Rs. 139 crores.
- 9116 t of LVB was landed (36.9% of total trawl catch) at Calicut, with a catch rate of 14.2 kg h^{-1}. This showed a decline by 4579 t against the previous year. Discards formed 1794 t. Among the LVB brought to the shore, lizard fishes contributed the highest (21.6%) followed by scads (15.2%) and soles (13.5%).
- Among the juveniles of finfishes landed at Calicut the major contributors were *Epinephelus diacanthus* (82%), *Nemipterus mesoprion* (28%) and *Saurida tumbil* (39%).

Landing of Low Value Bycatch at Mangalore

Monthwise Low Value Bycatch (LVB) landed at Veraval

Month	Effort (h)	Total catch (t)	Bycatch (t)	Bycatch (kg h^{-1})	Bycatch (%)
January	170060	12445	3549	20.87	28.52
February	160944	10471	4038	25.09	38.56
March	146128	10573	3397	23.25	32.13
April	150534	11755	3088	20.51	26.27
May	72530	6885	2782	38.36	40.41
June	3090	237	103	33.46	43.63
July					
August	41327	4984	30	0.71	0.59
September	170140	17218	3435	20.19	19.95
October	198509	23892	4218	21.25	17.65
November	168778	15849	3939	23.34	24.85
December	239137	20702	4758	19.9	22.98
Total	1521177	135011	33337	21.92	24.69

- An estimated 42 t of LVB was landed at Neendakara fishing harbour. LVB formed 8% of total trawl landings. Molluscs (41.5%) followed by fishes (30%) and crustaceans (20%) formed the bycatch.
- At Chennai, LVB formed about 14% of total trawl catch. The estimated landing was 6731 t, the discards being 193.4 t.
- Fishes formed 68.2% and crustaceans 26% of the total LVB landed at Chennai. The occurrence of juveniles in LVB was high forming 99% of total LVB landed in November. The price of LVB with fishes in decomposed condition varied from Rs. 3 to 5/kg whereas fishes suitable for human consumption were sold at Rs.100-280/kg.

- The total estimated LVB landed at Visakhapatnam was 5,180 t with a catch rate of 2.6 kg h^{-1}, forming 9.7% of total trawl landings showing an increase of 65% compared to 2008. The discards constituted 15,040 t with a catch rate of 7.6 kg h^{-1}, accounting for 28% of total trawl landings.
- LVB at Visakhapatnam was constituted by finfishes (64%), crustaceans (33%) and molluscs (3%). 60 genera/species of finfishes and 16 genera/species of crustaceans were identified. The LVB was sold at Rs.5/kg and the estimated value was Rs. 2.6 crores.

LVB landed at Calicut

Fishing by selective fishing gears

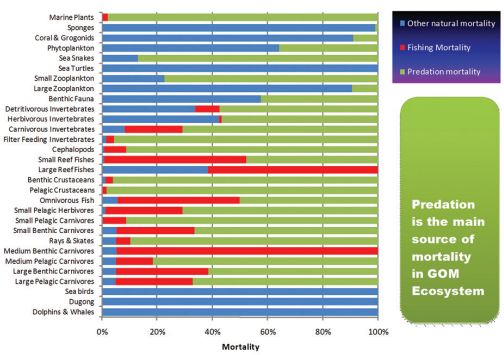
- An estimated 99.4 t of shrimps were landed by minitrawls at Pallithode with a CPH of 4.1 kg. *Metapenaeus dobsoni* (49%) and *Parapenaeopsis stylifera* (46.5%) were the major constituents. Peak landings of both species were in December. 57.5% of *M. dobsoni* and 31.8 % of *P. stylifera* females were below size at first maturity.
- An estimated 92.6 t of shrimps with a catch rate of 4.5 kg h^{-1} were landed by '*thallumadi*' at Tuticorin. 43.6 t of shrimps with a CPUE of 4.1 kg were landed at Mottagopuram and 49 t at Alangarathattu of which juveniles formed 21%. *Penaeus semisulcatus* formed 85% of total landings. The sizes of juveniles ranged from 43 to 83 mm TL. The shrimps were sold at Rs. 65 kg^{-1}. The economic loss to the fishermen by exploiting the juvenile shrimps of *P. semisulcatus* was estimated at Rs. 80 lakhs $year^{-1}$.
- At Tiruppalaikudi and Devipatnam along the Palk Bay coast, an estimated 74 t of *P. semisulcatus* was landed by '*thalluvalai*'. An estimated 5.1 million females of shrimp below 125 mm (size at first maturity) were harvested which would have otherwise given an additional revenue of Rs. 2.13 crores if allowed to grow to adult size (minimum 25g).

PROJECT CODE MF/IDP/02

PROJECT TITLE **Application of trophic modelling in marine fisheries management**

SCIENTISTS **K.S. Mohamed,** E. Vivekanandan, P.U. Zacharia, T.V. Sathianandan, V.D. Deshmukh, V.V. Singh, G. Mohanraj, P.K. Asokan, S. Ghosh, V. Venketasan, Bindu Sulochanan, E.M. Abdussamad, K.K. Joshi and P.S. Asha

CENTRES Kochi, Mumbai, Veraval, Chennai, Mandapam and Tuticorin



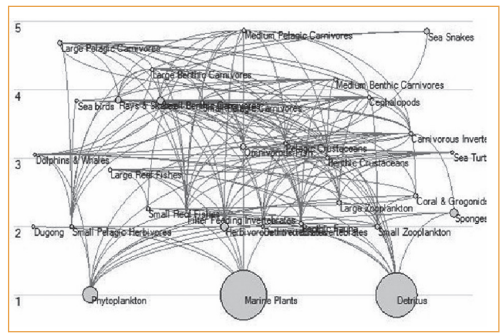
Split mortality percentages of different ecological groups in GOM ecosystem

Preliminary trophic model of Gulf of Mannar (GOM) developed

- The GOM model was mass balanced and fitted during the year. All input parameters were finalized during a workshop at Tuticorin during October 2009 and model balancing was achieved during the subsequent months. The summary statistics of the fitted model is given in table along with a comparison with the north-west coast (NWC) model.
- The GOM ecosystem has a higher total system throughput than the NWC ecosystem indicating that energy flows are higher in the GOM. Both ecosystems were predator dominant as evident from the mean trophic level of the catch. The gross efficiency values indicated that GOM is an ecosystem which has not reached maturity and therefore is susceptible to disturbances and perturbation. The net primary

production, net system production and total biomass is much higher in GOM as compared to NWC. The total biomass is considerably higher on account of the very high macrophyte (marine plants) biomass.

Parameter	GOM	NWC	Units
Sum of all consumption	1527	1982	t/km²/year
Sum of all exports	4415	2064	t/km²/year
Sum of all respiratory flows	902	1000	t/km²/year
Sum of all flows into detritus	4717	2446	t/km²/year
Total system throughput	11561	7492	t/km²/year
Sum of all production	4757	3652	t/km²/year
Mean trophic level of the catch	3.47	3.49	
Gross efficiency (catch/net p.p.)	0.00512	0.001551	
Calculated total net primary production	4438	3064	t/km²/year
Total primary production/total respiration	4.717	3.063	
Net system production	3536	2064	t/km²/year
Total primary production/total biomass	16.84	43.71	
Total biomass/total throughput	0.0228	0.009	
Total biomass (excluding detritus)	263.60	70.097	t/km²
Connectance Index	0.212	0.413	
System Omnivory Index	0.390	0.335	

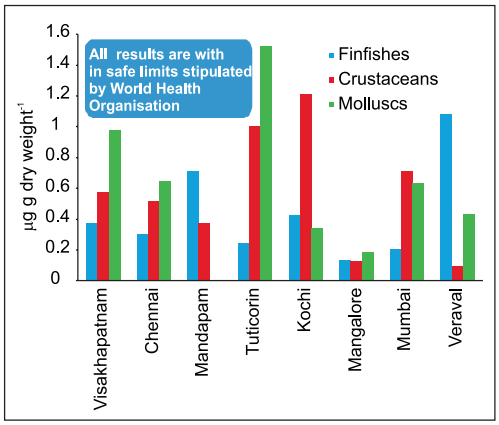


Split mortality percentages of different ecological groups in GOM ecosystem

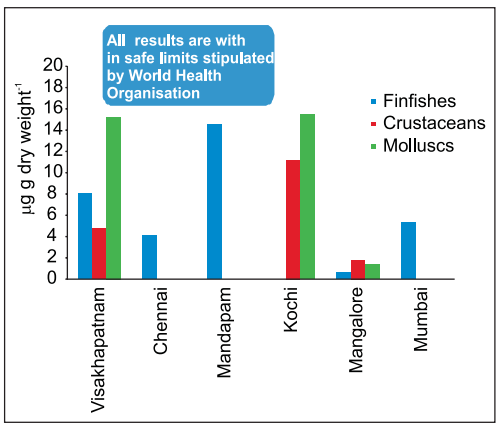
- Many ecological groups were not predated upon and also were not fished in the ecosystem (see split mortality percentage figure). Fishing mortality was highest for small and large reef fishes and medium benthic carnivores. In most exploited groups predation was the main source of mortality.
- The flow diagram of the GOM ecosystem is shown in the figure. The boxes which are scaled by biomass shows that the biomass of marine plants and detritus are the highest among all ecological groups. The connectance index which is a measure of how web-like the ecosystem is, was comparatively low in GOM.

Marine Environment

PROJECT CODE	FEM/01
PROJECT TITLE	**Impact of anthropogenic activities on coastal marine environment and fisheries**
SCIENTISTS	**P. Kaladharan,** V.V. Singh, K.Vijayakumaran, D. Prema, R. Jeyabaskaran, P.S. Asha, Bindu Sulochanan, Joe Kizhakudan and Gulshad Mohammed
CENTRES	Vishakapatnam, Chennai, Mandapam, Tuticorin, Kochi, Calicut, Mangalore, Mumbai and Veraval



Concentration of mercury in different groups of marine resources along the Indian coast



Concentration on arsenic in different resources along Indian coast

Occurrence of non-degradable objects in the fishing ground and along the Indian beaches

- From the trawl grounds off Calicut and off Mangalore, 120 to 230 g and 400-500 g of plastics respectively could be collected per haul of one hour duration.The weights as well as nature of biodegradable objects strewn along beaches were recorded. The intensity varied in different locations and ranged between 44 - 65 g m^{-2} at Cochin, 25 - 110 g m^{-2} at Kozhikode and 8 - 24 g m^{-2} at Mandapam. The non-biodegradable objects were comprised mainly of cola cups, carry bags, plastic ropes, plastic bottles, sachets, milk covers, thermocol etc.

Bioaccumulation of Mercury and Arsenic in marine resources

- Concentration of Arsenic and Mercury in seawater collected from all the study sites along both the coasts were either below detectable levels or showed very negligible levels within the permissible limits as per the stipulated standards. The intensity of bioaccumulation of mercury and arsenic in the tissues of selected finfishes, crustaceans and molluscs was analysed.
- The concentration of arsenic and mercury (µg g dry wt^{-1}) in selected finfishes, shrimps, molluscs and crabs is given in the figure. The intensity was within the permissible levels in almost all the samples. The bioaccumulation of mercury was low in finfishes, shrimps, and bivalves.
- Mangrove destruction: Mangroves are denuded mainly for house construction, agriculture or aquaculture. It is estimated that 1.5 acres of mangroves, mainly *Avicenia officinalis* was destructed recently near Kadalundi. However, 50 ha of mangroves are now protected under the Kerala Forest Department and afforestation with *Rhizophora* saplings have been carried out at 15 ha area.
- Dredging: Due to dredging near Rameswaram, the silicate content in the Palk Bay showed an average of 6.55 µg l^{-1} and in the Gulf of Mannar recorded 6.6 ug l^{-1} as against only 4.33 µg l^{-1} in the reference site.
- Monitoring of coastal waters: The hydrographic parameters and the level of mercury and arsenic at a polluted (outfall) site were compared with that of a reference site. Low levels of dissolved oxygen were encountered at Threspuram coast (Tuticorin), which sometimes reached anoxic levels in July 2009. At Vishakaptnam, the site at the sewage outfall was found to be hypoxic (0.869 mg l^{-1}).

The annual average values of hydrographic parameters and levels of selected trace metals in selected polluted / outfall (OF) and Reference sites (Ref) sites along the Indian coast

Parameters	Visakhapatnam		Chennai		Mandapam		Tuticorin		Kochi		Mangalore		Mumbai		Veraval	
	Ref	OF	Ref	OF	Ref	OF	Ref	OF	Ref	OF	Ref	OF	Ref	OF	Ref	OF
CO_2 (mg l^{-1})	30.3	nil	0.134	nil	nil	nil	27	3.17	nil	nil	nil	nil	230	20	nil	nil
BOD (mg l^{-1})	3.72	1.01	nil	nil	nil	nil	nil	nil	1.7	1.34	0.95	0.95	16	20	nil	nil
TSS (mg l^{-1})	103	56.08	30.6	13.4	36.45	14.4	28	26	16.25	8.84	19.7	4.57	12.6	11.1	153	122
NH_3 (mg l^{-1})	134	0.144	1.246	0.0	2.38	3.99	1.0	0.09	.26	.04	nil	nil	nil	nil	nil	nil
NO_3 (µgat l^{-1})	0.85	0.62	1.89	1.69	2.78	1.07	12.08	0.76	3.25	5.77	4.90	0.19	6.43	1.32	nil	nil
GPP (gCm^3 d^{-1})	0.76	0.16	1.58	1.13	nil	nil	2.91	1.37	.07	.05	nil	nil	nil	nil	nil	nil
pH	6.64	8.04	7.88	7.98	7.99	7.98	7.5	7.81	6.73	6.84	8.0	7.18	6.86	8.01	7.22	7.69
Hg in water (ppm)	0.02	0.01	0.013	0.01	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	0.01	bdl	0.015	0.01
As in water (ppm)	0.015	bdl	0.06	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	bdl	0.02	bdl	bdl	bdl
Hg in sediment (ppm)	0.823	0.535	0.245	0.231	0.079	0.11	0.321	0.123	12.73	0.395	0.29	0.24	3.03	0.24	0.226	0.113
As in sediment (ppm)	13.45	6.851	1.967	2.231	9.627	3.08	3.08	5.65	13.63	1.74	00	00	5.28	21.7	10.78	5.8

bdl –below detectable level

- Along Tuticorin at Threspuram, the CO_2 levels in seawater was high (42 mg l^{-1}) in September 2009. However, this elevated CO_2 levels did not affect the primary and secondary productivity of the area. Dissolved CO_2 at Kochi, Mangalore and Mandapam remained well below the detection levels.

PROJECT CODE FEM/02

PROJECT TITLE **Impact and yield study of environmental changes on the distribution shift in small pelagics along the Indian coast**

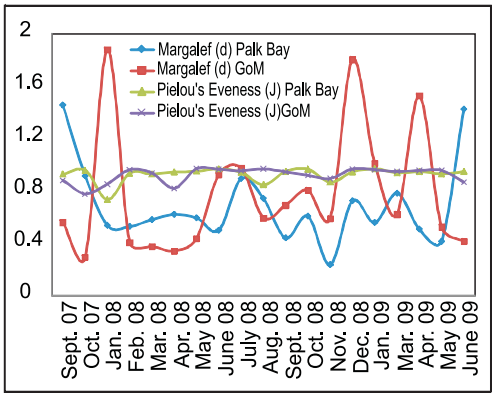
SCIENTISTS **K. Vijayakumaran,** P. Kaladaran, V.V. Singh, D. Prema, P.S. Asha, Bindu Sulochanan, Prathibha Rohit, T.V. Sathianandan, U. Ganga, Subhadeep Ghosh and R. Jeyabaskaran

CENTRES Veraval, Mumbai, Mangalore, Calicut, Kochi, Tuticorin, Mandapam, Chennai and Visakhapatnam

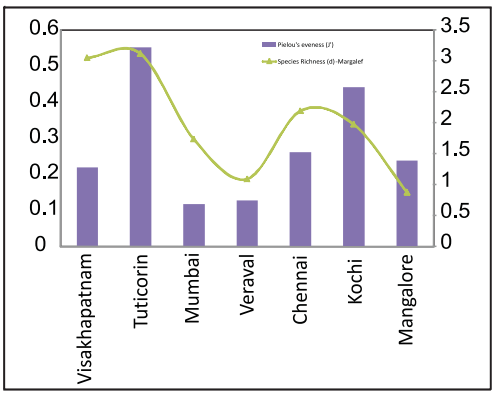
- The project was implemented in different locations along the east and west coast and environmental parameters were monitored. The catch data of small pelagics was sourced from the Fishery Resources Assessment Division of CMFRI.

- Hydrographic variation**:** The hydrographic variations in the surface waters from different locations along the east and west coasts were monitored. The average temperature was highest (32.45 ºC) in the Gulf of Mannar and lowest, (25.6 ºC) off Gujarat. The salinity variation was high along Kerala with the average value being 17.14 near the Cochin bar mouth. The average dissolved oxygen values were low in the surface waters off Tuticorin along Tamil Nadu and also off Mumbai in Maharashtra. The chlorophyll *a* values were highest in the Gulf of Mannar, off Tuticorin.

- Other abiotic hydrographic parameters**:** Nutrients of the surface water showed monthly variation and the average silicate (SiO_3) content of the water was highest along Kerala while phosphate (PO_4) content was the highest in the Gulf of Mannar (GoM) off Tuticorin and the nitrate (NO_3) in GoM off Mandapam. The gross primary productivity (GPP) was also high in GoM compared to other locations.



Variation in species richness and evenness in the phytoplankton community in the Palk Bay and Gulf of Mannar (GoM) during 2007-09



Average annual diversity indices of zooplankton at selected centres

Correlation between variations in environmental factors:

- At Kochi significant positive correlations between chlorophyll a and phosphate (r= 0.674) as well as Chlorophyll a and silicate (r = 0.658) were observed at surface waters of 10 m depth. At 20 m depth chlorophyll a of surface waters showed highly significant correlations with phosphate (r = 0.742) and silicate (r = 0.839).
- Phytoplankton**:** Phytoplankton samples from the surface waters were collected and identified. The average density was highest off Veraval along west coast and off Chennai along east coast. Comparison of the phytoplankton diversity in the GoM and Palk Bay regions indicated varied intensity and community structure. In the GoM *Nitzschia longissima* (9.4%) and *Nitzschia sigma* (6.61%) were the dominant species while in the Palk Bay *Coscinodiscus excentricus* (6.88%) and *Coscinodiscus marginatus* (6.71%) were the major species.
- Community variation**:** Variation was observed in the phytoplankton community near the shore and in the offshore region (20 m depth) off Mangalore. In the near shore area 64 species were prominent and among these *Thallasionema nitzschioides* (6.8%) and *Coscinodiscus lineatus* (4.8%) were the major species. In the off shore region 74 species were present and *Cyclotella striata* (6.3%) and *Nitzschai seriata* (5.4%) were the dominant species. Monthly variation was also observed in the diversity indices.
- Zooplankton: Copepods formed the major group of zooplankton at Visakhapatnam (87.12%), Chennai (84.19%), Tuticorin (48.06%), Veraval (95.52%) and Mangalore (88.4%). In Kerala, decapods were dominant forming 53% of the community followed by copepods (31.5%). In Visakhapatnam, fish eggs formed 2.99% of the zooplankton and among the different sampling sites, Tuticorin recorded the highest diversity index followed by Kochi.

Correlation between environmental parameters and small pelagics:

- Statistical analysis of the environment data with landing of pelagic fishes like mackerel and sardine gave the following significant relations

Annual mean values of key hydrological parameters of the sea surface waters of selected stations

Station	Temperature, (^{0}C)	pH	Salinity (psu)	DO (ml l^{-1})	Chl a (mg m^{-3})
Gujarat (off Veraval)	25.60	7.90	35.85	3.38	
Gujarat (off Somnath Beach)	26.61	7.72	34.93	3.08	
Maharashtra (off Versova)	29.65	7.75	33.46	2.00	0.29
Maharashtra (off Apollobunder)	31.05	7.50	30.91	2.41	2.42
Karnataka (off Mangalore 20 m depth)	29.04	7.99	32.34	4.47	5.25
Karnataka (off Mangalore 10 m depth)	29.83	8.06	34.28	4.31	3.91
Kerala (near Cochin barmouth)	29.75	7.39	17.14	4.17	1.49
Kerala (off Cochin 10 m depth)	29.47	7.87	28.28	3.90	0.94
Kerala (off Cochin 20 m depth)	29.13	7.95	29.73	4.41	0.85
Tamil Nadu (GoM- Tuticorin -II)	29.80	7.81	32.27	2.54	6.1
Tamil Nadu (GoM- Tuticorin -I)	30.09	7.97	32.69	2.69	10.86
Tamil Nadu (Palk Bay off Mandapam)	30.42	7.98	32.61	4.43	1.79
Tamil Nadu (GoM- off Mandapam)	32.20	8.24	37.90	4.93	5.69
Tamil Nadu (off Chennai)	29.11	6.89	34.18	4.56	
Andhra Pradesh (off Visakhapatanam)	27.59	7.90	32.45	3.82	0.15

- A significant negative correlation (r = - 0.612) was obtained between subsurface temperature and mackerel landing along Kerala coast.
- A positive correlation (r = 0.622) was obtained between chlorophyll *c* concentration and mackerel landing in Kerala.
- Positive correlation (r = 0.491) between primary productivity and sardine landing at Tuticorin.
- Positive correlation (r = 0.407) between dissolved oxygen content of subsurface waters and mackerel landing at Tuticorin

Annual mean of nutrients and gross primary productivity of sea surface waters of selected stations

Station	SiO_3 (µg at l^{-1})	PO_4 (µg at l^{-1})	NO_3 (µg at l^{-1})	GPP (mg C l^{-1} hr^{-1})
Karnataka (off Mangalore 10 m depth)	16.90	0.82	2.10	
Karnataka (off Mangalore 20 m depth)	8.98	0.44	0.56	
Kerala (near Cochin Barmouth)	51.48	1.36	1.46	0.11
Kerala (off Cochin 10 m depth)	17.22	0.43	0.94	0.05
Kerala (off Cochin 20 m depth)	11.54	0.45	0.44	0.09
Tamil Nadu (Gulf of Mannar - Tuticorin - I)	0.02	2.16		0.39
Tamil Nadu (Gulf of Mannar - Tuticorin - II)	0.02	2.24		0.55
Tamil Nadu (Palk Bay off Mandapam)	6.26	0.093	1.59	
Tamil Nadu (Gulf of Mannar-off Mandapam)	5.03	0.762	4.35	
Andhra Pradesh (off Visakhapatanam)	0.136	0.147	0.06	

Mariculture

PROJECT CODE	**MD/IDP/01**
PROJECT TITLE	**Technology development for seed production of Shellfish**
SCIENTISTS	**Manmadan Nair,** Josileen Jose and Joe K. Kizhakudan
CENTRES	Mandapam, Visakhapatinam, Calicut and Kochi

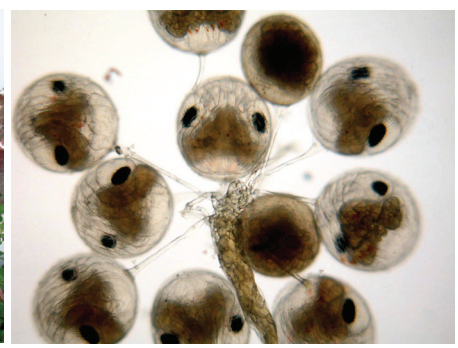
Hatchery raised transplantable spat of pearl oyster *P. fucata*

Pearl oyster *P. fucata* spat

- About 30,000 numbers of transplantable spats of pearl oyster *Pinctada fucata* were raised in the hatchery under conventional rearing method. About 1700 hatchery raised spat were supplied for farming.
- L-dopa was tested for inducing spat settlement of pearl oyster *P. fucata* and chloramphenicol treatment for control of ciliates in hatchery were standardized.
- From 14.86 million zoeae of blue swimmer crab produced in hatchery experiments at Mandapam, 4130 baby crabs were produced (survival ranging from 0.2 to 16.8%) and was used in farming experiments in raceway and mariculture farm.
- High density shrimp larval rearing and nursery rearing were carried out in cement tanks.
- For lobster fattening shallow basin recirculatory raceways supported on FRP legs were set up at the Kovalam Field Laboratory in March 2009. The survival was above 80% during the first five days of rearing.
- Mass larval rearing in raceways was carried out at KFL from August 2009 onwards. The growth and survival up to final phyllosoma stage was good and showed improvement over the results obtained in earlier experiments on mass rearing. The average survival rate at each stage was – PI to PII- 60%; PII to PIII- 51%; PIII to PIV- 24%; PIV to Nisto - 2%.
- Over a period of nine months, sand lobster broodstock have been raised from seed stage with 75% survival rate in a high density rearing system, with sand substrate and no water exchange.
- Maturation and breeding of the ornate spiny lobster *P. ornatus,* in captivity without eye ablation or hormonal administration was achieved for the first time at Kovalam Field Laboratory, RC of CMFRI, Chennai.

T. orientalis fattened at Kovalam

Adult *Panulirus ornatus*



Panulirus ornatus embryo

PROJECT CODE	MD/IDP/02
PROJECT TITLE	**Technological upgradation in molluscan mariculture**
SCIENTISTS	**V. Kripa,** T.S. Velayudhan, K.S. Mohamed, P.K. Asokan, P. Laxmilatha, I. Jagadis, C.P. Suja and Geetha Sasikumar
CENTRES	Mangalore, Calicut, Kochi, Tuticorin and Visakhapatnam

- During the year 2009, the farmed bivalve production by small scale commercial farms was estimated at 19882 t, with the entire production from Kerala alone. Mussel production was estimated at 18,432 t and that of oyster at 1450 t.

Estimated farmed mussel production by the off-bottom and on-bottom methods in different districts of Kerala

District	Off-bottom	On-bottom	Total
Kozhikode	1345	618	1963
Malappuram	32	910	942
Kannur	0	1929	1929
Kasaragod	12168	0	12168
Kollam	550	210	760
Ernakulam	500	90	590
Trissur	75	5	80
Total mussel production	14670	3762	18432

- About 1727 oysters were successfully harvested from the demonstration cum research farm at Kottathurithy, Moorad estuary; 1.58 kg of meat was extracted. Along with this, 120 oyster rens producing 12 kg of oyster meat were also harvested.

Spawning of green mussel *Perna viridis*

- At Visakhapatnam Regional Centre of CMFRI, through captive spawning of the green mussel *P. viridis* during August and December 2009, 2.65 million larvae were obtained which developed to the "D' stage larvae within 24 h and after further growth and development the pedivliger stage was attained on the 19th day. Spat settlement began on the 21st day and continued up to the 30th day. About 1.7 lakh spat, settled were reared in the hatchery.
- The mussel spat settled in the Visakhapatnam hatchery grew to an average total length of 25.2 mm (DVM) and total weight 2.3 g in 86 days of rearing. The spat were transferred to the sea for further growth. The mussels grew to an average total length (DVM) of 37.94 mm, AVM of 19.44 mm, thickness of 13.13 mm and average total weight of 5.13 g in 121 days. Large scale spat production has thus been achieved in the Marine Hatchery of the Visakhapatnam Regional Centre.
- More than 40,000 spat of green mussel were produced from 6 million larvae at Tuticorin hatchery of CMFRI in December 2009. The early umbo stage was observed for three days (7th to 9th) and developed to the umbo stage which was prolonged and the larvae metamorphosed to form the pediveliger by 27th day. On 31st day, complete settlement was observed.

Monitoring the growth of farmed oysters at Moothakunnam, Kerala

Training on new methods on mussel seeding in Sattar Island, Kerala

Production of clam and oyster seed

- Nearly 50,000 spat of two species of clam *Paphia malabarica* and *Meritrix meritrix* were produced; the larvae of *M. meritrix* settled in 18 days while that of *P. malabarica* took 21 days to settle.
- More than 50,000 spat of the edible oyster *Crassostrea madrasensis* were produced. Along with cultched spat, cultch-less spat were also produced and grown separately.
- Hatchery trials for production of pearl oyster seed were conducted and about 30,000 oyster spat of 10 mm size were produced and used for farming and other use.

Tissue culture of pearl oysters for pearl production

- Raman Spectroscopic Analysis was done on experimental beads and the characteristic aragonite Raman peaks with high intensity was obtained to confirm the nacre growth.
- Cell proliferation and crystal formation occurred in pearl oyster and pteria mantle explant and organ cultures. Pearl sac formation and crystal formation occurred in different materials like glass bead, teflon, cover slip and sand and more crystal coating occurred on shell bead than other materials.

Pearl culture

- At the Regional Centre of CMFRI Visakhapatnam, 225 pearl oysters were nucleated during the period. Rejection of implanted nucleus was high and 45 oysters with retention of implanted nucleus are being maintained in the onshore rearing system for pearl production.
- *Pinctada margaritifera* was maintained and conditioned in the hatchery of Visakhapatnam Regional centre of CMFRI for spawning. A mild spawning occurred on 27-07-09. The larvae were maintained in one tonne tanks, but after 13th day of the D - shaped stage, total mortality occurred.

Popularization of bivalve farming

- In north Kerala, four trainings on mussel farming, two on mussel/ clam depuration and one on edible oyster farming were organized in collaboration with State Fisheries department. Awareness programme on better production practices and hygienic handling of bivalves was conducted in collaboration with MPEDA at Valliyaparamba Panchayat Hall on 27.10.09 and at Padanna Panchayat Hall on 28.10.09.
- In central and south Kerala, two training programmes were organized on scientific aspects of mussel depuration. In central Kerala, at Vaikom, a training programme and workshop was conducted on clam farming, depuration and conservation in association with clam fishermen cooperative of Vaikom.
- In Karnataka, a training program on 'mussel and oyster farming' was organised on July 22, 2009 in association with BFFDA, Udupi at Moogaveera Sabha Bhavan, Kundapura for 64 participants under the centrally sponsored scheme of BFFDA.

Mussel farm in Karnataka

Mussel farming through participatory programme

- In Karnataka, wooden racks were fabricated at 1.5-2.5 m depth (during low tide) at Saligrama by fishermen and green mussel *Perna viridis* was seeded at the rate of 750-1500 g^{-1} during October 2009 to January 2010.

PROJECT CODE	MD/IDP/03
PROJECT TITLE	**Development of broodstock, captive breeding and seed production techniques for selected marine food fishes and ornamental fishes**
SCIENTISTS	**G. Gopakumar,** K.R. Manmadan Nair, Grace Mathew, K. Madhu, Rema Madhu, M.K. Anil, Boby Ignatius, Kajal Chakraborthy, P. Vijayagopal , P.K. Asokan, A.K. Abdul Nazar, Ritesh Ranjan, C. Kalidas, G. Tamilmani, M. Sakthivel and Biji Xavier
CENTRES	Mandapam, Visakhapatnam, Vizhinjam, Calicut and Kochi

Food fishes

- At Vizhinjam 80 nos. of Cobia (*R. canadum*) weighing 1 to 10 kg were collected and reared in cages attached to the raft moored in Vizhinjam Bay. Of which, 42 numbers were successfully transported to Mandapam RC of CMFRI and remaining 27 specimens are being reared in the cages for transporting later to Mandapam.

Six meter diameter HDPE cages for cobia broodstock

- At Mandapam, a total of 41 numbers of cobia brood fishes weighing 4 to 25 kg were stocked at a density of about 1.5 kg m^{-3} in four open sea cages. The fish were fed daily with fresh sardines (70%) and portunid crabs (30%) at the rate of 5% of body weight. Additional supplements of vitamins (mainly E and A), HUFA (fish oil, squid liver oil, *etc.*) and mineral mixtures were periodically added to the diet.

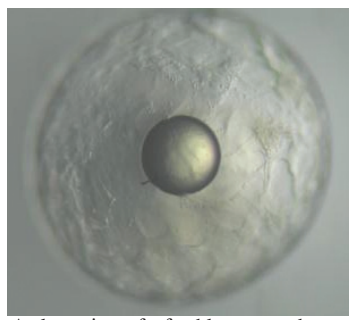
Cannulation of cobia brooders

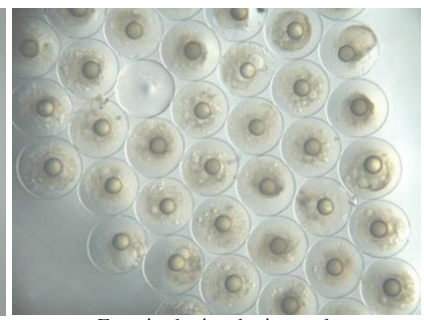
Different dosages of human chorionic gonadotrophin (HCG) used for inducement experiments in cobia

Date of Expt.	Sex ratio M:F	Hormone and dosage level (IU kg^{-1} body wt.)	Route of injection	Time of injection	Date and time of response	Result
17-06-09	2: 1	HCG : 1000 - Female 500 - Male	Intra-muscular	16.00 hrs	Not responded till 19-06-09	Spawning did not occur
10-08-09	2:2	HCG : 1000 - Female 500 - Male	Intra-muscular	15.30 hrs	12-08-09 Time 21.30 hrs	Eggs released, ova diameter ranged between 0.8-1.1mm, with fully developed oil globule. Eggs not fertilized.
25-08-09	2:1	HCG : 500 - Female 275 - Male	Intra-muscular	16.00 hrs	27-08-09 Time16.30 hrs	Eggs released, ova diameter 1.0-1.1 mm, with fully developed oil globule, signs of fertilization noted but further embryonic development was arrested.
25-08-09	2:1	HCG : 500 - Female 275 - Male	Intra-muscular	17.00 hrs	Not responded till 28.08.09	Spawning did not occur
19-10-09	2:1	LHRHa : 20 ìg^{-1}/kg body wt - Female 10 ìg^{-1}/kg body wt – Male	Intra-muscular	15.30 hrs	Not responded till 22.10.09	Spawning did not occur
11.03.10	2:1	HCG : 500 - Female 250 - Male	Intra-muscular	13.00 hrs	Spawned on 13.03.10 at 0430 hrs	2.1 million eggs were spawned and hatching occurred on 14.03.10.

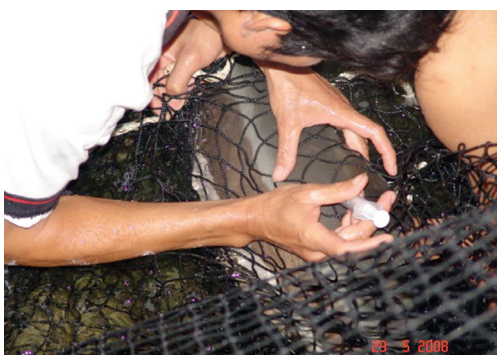

Cobia brooders inside the spawning tank

- Healthy fishes weighing above 10 kg were selected for cannulation to ensure the optimum size of ova (>500 µm). The males were also checked for their maturity by applying gentle pressure on the belly for the milt to ooze out.
- Mature brooders were brought from the cages and transferred to 100 t cement tanks. The sex ratio maintained was two males for one female except in one experiment, where two females and one male were used. The optimum temperature (27± 2°C) and salinity (30-34 ppt) were maintained and monitored.
- Inducement experiments were conducted using human chorionic gonadotrophin (HCG) at different dosages or gonadotrophin releasing hormone (GnRH) analogue at a dosage of 20 µg kg^{-1} body weight for females and 10 µg kg^{-1} for males.
- Six breeding experiments were carried out during July - October, 2009.
- Spawning was observed at 0430 hrs on 13.03.2010 with total eggs estimated at 2.1 million. About 90% fertilization was recorded (*i.e.*@ 1.9 million). The eggs collected by a 500 µ mesh were stocked in incubation tanks at varying densities.


A close view of a freshly spawned egg


Eggs in the incubation tank

- The eggs hatched after 22 hrs of incubation at a temperature range of 28-30 ºC. The percentage hatching was 80% and the total number of newly hatched larvae was estimated as 1.5 million.
- The newly hatched larvae measured 2.2-2.7 mm in total length. The mouth opening of the newly hatched larvae measured around 200 µ.
- The larvae were stocked in 15 FRP tanks of 5 t capacity each with an average density of 50,000 larvae per tank for intensive larviculture. The remaining larvae were stocked in three 100 t cement tanks for extensive larviculture trials.
- The intensive larviculture tanks were provided with green water at a density of about $1x10^5$ cells ml^{-1} and rotifers enriched with DHA SELCO at a density of 6-8 nos. ml^{-1}. In the extensive larviculture tanks, green water along with rotifers was maintained.
- A total of 68 numbers of Pompano (*Trachinotus blotchii*) weighing 1.5 to 2.0 kg are being developed into broodstock. Cannulation done in November 2009 revealed that the fishes were immature.
- At Vizhinjam, a new candidate species *Serriola nigrofasciata* is taken up for studying the biology for evaluating feasibility of broodstock development and seed production.


Administration of Hormones

Seriola nigrofasciata at Vizhinjam

- At Visakhapatnam, thirty two numbers of *Epinephelus tauvina* (greasy grouper) were collected from commercial hooks and line catches and conditioned for broodstock development. Out of this, 7 fishes were stocked in FRP tanks, provided with biological filters in the hatchery and the rest (25 nos.) in 6 m diameter open sea floating cage moored off Visakhapatnam.
- The groupers stocked in the cages are being maintained as the female broodstock. Fishes are fed twice a day @ 5% body weight with *Decapterus russelli* fortified with Vitamin E and cod liver oil.
- Groupers maintained in the hatchery were given fortnightly formalin treatment and fed once in a day with *D. russelli* @ 5% of their body weight. Feed fortified with 17 α- methyl testosterone, vitamins, and essential oil is given. After 3 h of feeding, 50% water exchange is done.
- After two months of testosterone feeding, broodstock was maintained at 1:1 sex ratio in the hatchery in re-maturation tank by introducing females from the cage in the sea.
- *Lutjanus argentimaculatus* (30 numbers) weighing 1 - 2.3 kg were collected from the estuarine environment and being maintained for broodstock development at Kochi.

Ornamental fishes

- Scaling-up of seed production of *Amphiprion percula, A. sebae, Chrysiptera cyanea, Pomacentrus caeruleus and Dascyllus aruanus* were carried out at Mandapam. At Vizhinjam RC, three species of clown fishes *viz., A. ocellaris, A. sebae* and maroon clown *Premnas biaculeatus* were mass produced in the hatchery. With the sale of ornamental fishes at Mandapam and Vizhinjam, about Rs.2,20,000/- was remitted to ICAR account.
- At Kochi, spawning of *A. clarkii* was obtained in captivity and larvae were raised by feeding copepods, rotifers and *Artemia.*

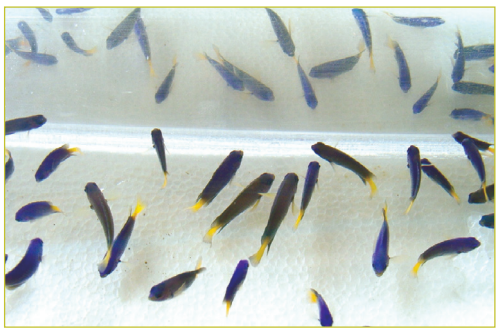
Amphiprion frenatus with egg

Amphiprion frenatus egg (6 day old)

Grouper (*E. tauvina*) broodstock in sea cage at Visakhapatnam

Amphiprion sebae

Chrysiptera cyanea



Pomacentrus caeruleus

- Ten pairs of *A. ocellaris* were developed from the hatchery-produced juveniles through feeding PUFA enriched adult *Artemia*. The study revealed that fat enriched live feed is inevitable for the gonadal maturation and larval survival.
- Gonadal maturation of 3 pairs of midnight angel *Centropyge flavipectoralis* was analysed after rearing for six months of their pair. The females showed initial ovarian development.
- Breeding of *A. frenatus* and larval rearing was carried out for the first time in India
- Broodstock development of the smoke angel *Apolemichthys xanthurus* was carried out. Signs of gonadal development were noted in the broodstock.
- Live feeds such as rotifer and *Artemia* nauplii were enriched with cod liver oil, and fed to the dotty back showed high somatic growth compared to wet feed. Initial gonadal growth was slow in males when compared to females.
- Pair formation studies were completed for the three pairs of *Amphiprion nigripes* collected from the wild.

PROJECT CODE	**MD/IDP/04**
PROJECT TITLE	**Innovations on sea cage farming and development of sustainable Capture Based Aquaculture**
SCIENTISTS	**G. Syda Rao,** G. Gopakumar, K.K. Philippose, Imelda Joseph, G. Maheswarudu, R. Narayana Kumar, A.K. Abdul Nazar, C. Kalidas, M. Sakthivel, Ritesh Ranjan, M.K. Anil, B. Santhosh, Shoji Joseph, Boby Ignatius, A.P. Dinesh Babu, Sujitha Thomas, Gulshad Mohammed and V.D. Deshmukh
CENTRES	Kochi, Vizhinjam, Mandapam, Karwar, Visakhapatnam, Mangalore, Chennai and Mumbai

GI round cage

Netlon cage

Innovations in cage mooring system

- Dyneema mooring system has been introduced for cage mooring in open sea. It needs no metal shackles and rings for connection of floats. It comes with the entire mooring set attached with a gabion box. Dyneema fibre is 15 times stronger than steel, 4-5 times stronger than polyamide, lighter than water and extremely durable. It has longer life time and reduced maintenance. It is bite resistant and can even pull oil tankers. Dyneema is not affected by seawater, whereas, upto 15% strength of nylon is lost in seawater. Metal mooring gets corroded and dyneema is a solution for such problems in mooring.
- In open backwater river system at Cochin, due to the limited space available for cage rotation, the single point mooring system was not practical. So, the cages are permanently anchored at two points without any rotation facility to it. This is advantageous to reduce the pressure on nets due to the two way flow. For better floatation of 6 m dia cages, diesel barrels are also used. The HDPE cylindrical floats have been used for flotation of 2 m dia HDPE cages.
- At Chennai, indigenous Sintex milk cans/sealed/PUF filled tested buoys are used. Solar flicker lamps (6 Vx2 cell powered) flickering only in the night are used as night navigation signals on the cage.

Innovations in cage design

- At Karwar, a low cost round (6 m dia) metal cage was designed using GI pipes and floated on 10 HDPE barrels filled with 30 pounds of air. It appears to be cost-effective than HDPE cages.

- At Mangalore, cages of netlon material were designed with inner nylon net to grow the juveniles discarded in fishery.
- At Cochin, 2 m dia HDPE cages were used for farming trials. The frame was provided with two nets - an inner grow out and an outer predator net. To improve the floatation of the cages, four numbers of HDPE cylindrical floats were used. It has been observed to be suitable for operating in a backyard culture system for small households and individuals.
- Fortnightly fish seed collections were made from different areas at Vizhinjam, Mullur, Kottappuram and Poovar. Operations in early hours of the day or in the evening especially before and after sunset yielded more fish seeds. Seed obtained include species such as *Siganus javus*, *Siganus canaliculatus*, *Mugil cephalus*, *Valamugil seheli*, *Liza* sp., *Caranx* sp., *Therapon* sp., *Apogon* sp., *Ambassis* sp, *Platax* sp., *Balistes* spp.. The seed availability along Vizhinjam coast is given in the table below.

2 m dia HDPE cage

Fish seed availability from different sites along Vizhinjam coast

Species	August %	September %	October %	November %	December %	January %	February %	March %
Siganus javus	13	9	5	9	4	3	1	0
S. canaliculatus	12	14	2	7	9	2	4	2
Mugil cephalus	4	2	0	0	2	0	0	0
Valamugil seheli	17	19	22	15	17	43	39	44
Liza sp.	3	4	2	5	6	4	6	10
Caranx sp.	4	14	17	7	11	2	4	5
Therapon sp.	12	2	22	8	8	22	18	16
Apogon sp.	18	13	2	17	7	11	7	11
Ambassis sp.	5	8	5	8	11	7	12	6
Platax sp.					3	0	0	
Balistes sp.					7	0	0	0
Etroplus sp.							2	3
Miscellaneous	12	15	23	24	15	6	7	3
Total	100	100	100	100	100	100	100	100

- At Cochin area, survey of the Vypeen Island from Puthuveypu to Munambam was conducted to study the availability of fish seed and to identify suitable seed collection sites. Seed collection sites were mostly concentrated near Puthuveypu and Moothakunnam. Milk fish *Chanos chanos* (February- May, 1-2 cm), grey mullet *Mugil cephalus* (June to August, 1- 2 cm), *Liza* spp. (year round, 1-2 cm), red snapper *Lutjanus* sp. (June to August) and *Eleuthronema tetradactylum* (September- December, 8-10 cm) are available. Trials on nursery rearing techniques for *M. cephalus* were conducted at KVK pond and farmers' ponds at Malippuram and Cherai. Nursery rearing of *C. chanos* was tried in hapas in open backwater at Pizhala as well as Moothakunnam and both were not successful due to the sudden influx of land run off leading to mass mortality in open water systems.
- At Mangalore, a detailed survey of the estuaries and coastal waters were done during the period to study the availability of fish seed along the coast. The gears operated during the monsoon season were hand trawls, cast nets and gillnets. It was observed that, during the monsoon season, lots of juveniles of economically important species are also caught along with the market sized fishes. Common species available in the estuaries are *Sillago sihama*, *Etroplus suratensis*,

Fish seed collection at Vizhinjam

Bamboo trap for red snapper collection at Cochin

Packing of seed

Ornamental fish cage at Mandapam

Gerres filamentosus, Bothus sp., Gobids, *Grammoplites* spp and *Lutjanus russelli.* Among these species, *Etroplus* sp. and *Gerres* juveniles are caught in large quantity in Netravathi and Gangoli estuaries. Usually these are discarded and efforts are being made to collect these fishes and grow them in the cages.

- Survey of the coastal stretch from Pulicat to Mahabalipuram was done to identify seed collection sites. Seed collection sites were identified and seed of different fishes and lobsters such as milk fish *Chanos chanos*, grey mullet *Mugil cephalus,* and silver biddy *Gerres filamentosus*, sand lobster *Thenus orientalis* and spiny lobster *Panulirus homarus* were collected and brought to the laboratory at Kovalam. Trials on nursery rearing for the seed were conducted at Kovalam.

Design and fabrication of nets and traps for seed collection

- At Vizhinjam, two new nets were designed and fabricated for the collection of fish seed. One net for fish above 15 mm was made using 10 kg netting of mesh size 6 mm and the length of the net was 25 m and breadth 5 m. Floats were used at 60 cm intervals and sinkers at 10 cm intervals. The second net was made using mosquito netting having 5 m length and 1.5 m breadth.
- At Cochin, two types of traps were experimented for seed collection of red snapper *L. argentimaculatus* at Moothakunnam. One made of bamboo and another of iron. Bamboo traps were found to be suitable for juvenile collection of red snappers. The metal trap was attracting crabs only.

Nursery rearing and farming operations in cages

- At Cochin, about 3000 seed of *Valamugil seheli* and *Liza* sp. brought from Vizhinjam are being reared in farmer's pond at Malippuram in hapas. After two months, it has attained 4-5 cm size. Other species reared in nursery for stocking in cages were *Mugil cephalus* and *Chanos chanos*.
- At Cochin, farming trials were carried out in 2 m dia HDPE cages. *Etroplus suratensis, Lutjanus argentimaculatus, Lates calcarifer etc.* are being farmed in these cages. For feeding, mainly commercial pellet feed and clam meat are used
- The average growth observed for about a 100 g *L. argentimaculatus* juvenile after two months was 350 g and a 300 g size fish reached about 1 kg. *E. suratensis* attained a weight of 100 g after two months.
- At Mandapam, hatchery produced juveniles of marine ornamental fishes *Amphiprion sebae* and *A. percula* were stocked in small sea cages of 2 m diameter. A total of 600 numbers of *A. percula* and 1000 numbers of *A. sebae* juveniles were stocked in sea seed cages.
- At Uppunda village in Mangalore, in the 3- 4 km estuary with an average depth of 2.5 m, the concept of CBA was introduced by collection of *Lutjanus argentimaculatus* fingerlings of 80 mm size and stocking in floating cages of 2.5 m x 2.5 m x 2 m made of netlon of mesh size 30 mm lined with nylon net. The fishes were fed with

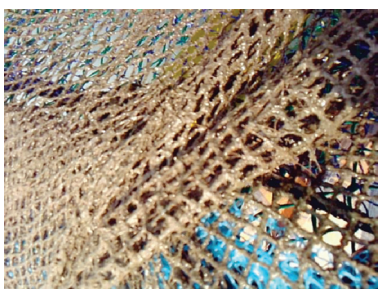
low-cost trash fishe and the growth was monitored regularly. At Gangoli, the 2 m netlon cages were distributed to fishermen. About 500 numbers of *Etroplus* sp. were stocked and fed with artificial feed. Another cage was designed and supplied to a progressive farmer to rear mullets with feeding using rice bran. Mullet and *Gerres* sp. juveniles discarded from the shore seine fishery is collected and stocked in the pond in which seabass cages are erected to utilize the water body outside the cages. Five hundred numbers of mullet seeds of 30 mm size is stocked in the pond which was found to grow to a size of 50 mm in one month of stocking.

Harvests

- At Mandapam, the ornamental fish harvest in cage was arranged and 400 numbers of *A. percula* were harvested and an amount of Rs. 40,000/- was realized through the sale @ Rs.100 per piece and was accounted under the revenue generation of the Centre.
- Periodic partial harvests are being carried out at Mangalore as and when the fish reach marketable size in cages.

Problems and prospects

- At Cochin, while doing cage culture in backwater river systems, major problems encountered were heavy fouling due to edible oyster leading to weight increase of the net causing net damage, difficulty in net exchange and reduction in flotation of the cage frame. Settlement of oyster leads to abrasion of fish on it, resulting in injury and scale loss leading to delayed mortality. Major advantages observed are good water flow, safe mooring and better growth to the stock.



Algal fouling on net cage

Oyster fouling on net cage

Social engineering

- At Cochin, the cages are being managed (feeding, cleaning, security *etc.*) by two families at Moothakunnam as their part-time avocation. More families are coming forward to take up cage farming in the area.
- At Uppunda in Mangalore, demonstration of CBA in netlon cages has encouraged the fishermen to install similar type in the estuary and at present the estuary has five cages stocked with fingerlings of *Lutjanus argentimaculatus*, *Etroplus suratensis* and *Lates calcarifer*. The fishermen view this as an alternative source of income when adverse climatic conditions prevent them from venturing into the sea. Similar cages are also installed in Kundapur estuary and the small size fishes which are otherwise discarded are grown into marketable size in these cages.
- A marine fish farm is being developed at Karwar in which besides sea bass, mullets, red snappers and mussels are cultivated.

Fish seed stocking in netlon cages at Uppunda, Byndoor

Harvesting of ornamental fish from cage

E. suratensis in hapa at Vizhinjam

Marine farm at Karwar Research Centre of CMFRI

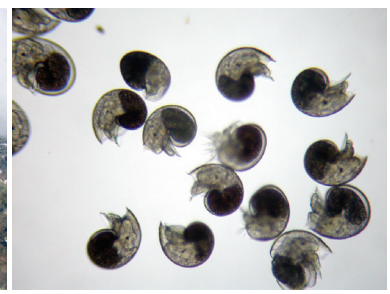
PROJECT CODE	**MD/IDP/05**
PROJECT TITLE	**Mariculture of selected species of conservation importance**
SCIENTISTS	**I. Jagdish,** Boby Ignatius, A.K.Abdul Nasser, K.Vinod and C. Kalidas
CENTRES	Tuticorin, Mandapam and Kochi

Cypraea tigris - broodstock

Cowry shells

- Survey for cowry shells were conducted in the Tuticorin Harbour basin areas and five species of cowry shells *ie*. *Cypraea arabica*, *C. caurica*, C. *annulus*, C. *caputserpentis* and *Cypraea* spp. could be obtained in this area.
- Few specimens of *C. tigris* was also collected from the landing centre and maintained under laboratory conditions.
- Observation on the spawning of *C. arabica* in wild was made and it was found that the egg mass had 165 egg cases and an average of 350 veliger in each case. Each live veliger measured 98 µ and had developed ciliated velum. Partial hatch of the egg cases were observed on transfer of the egg case to laboratory. The hatched veligers were reared with *Isochrysis galbana* as feed, but survived only for 5 days.

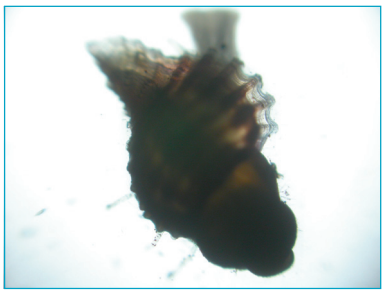

Egg case brooding of *Cypraea arabica* observed in wild


Newly hatched veligers of *Cypraea arabica*

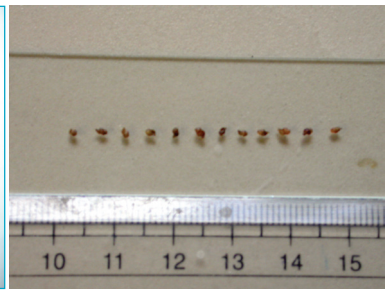
Chicoreus spp.

- Eight specimens of broodstock of *Chicoreus* spp. measuring 80-110 mm and 49-165 g were collected in June 2009 from the landing centre discards and transported to hatchery and maintained for studying their survival, breeding and larval development for mass seed production. Year-round maintenance with live clams as feed gave 100% survival.
- Spontaneous breeding commenced during June 2009 and continued up to October 2009 and ceased later. Total number of egg capsules at the end of the breeding period ranged from 110-140 egg cases (spawning in June) and decreased to 10-40 in October 2009.
- The number of eggs in each of the egg case was highly varying (about 100- 380 nos). Observations on the intra-capsular egg development were made and recorded from viable egg cases. After an incubation period of 20 days, the veligers hatched. However, after development the number of viable veligers within the egg case ranged from 18 to 30 nos. only. The newly hatched veliger showed differential lengths ranging from was 1.7 to 1.9 mm and juvenile rearing was successful up to 2.9 mm size.

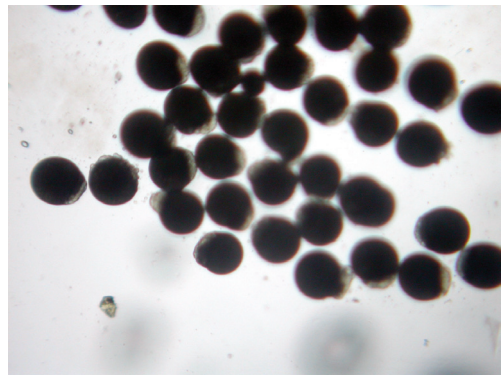

Spawning of *Chicoreus* sp.



Juvenile *Chicoreus* sp.



Group of juveniles (*Chicoreus* sp.)



Developing eggs (*Chicoreus* sp.)

Common spider conch shells

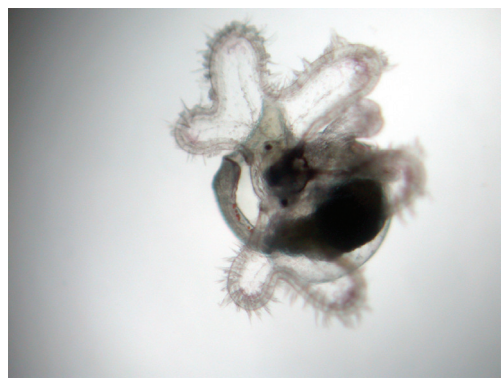
- Live specimens of *Lambis lambis* discarded from landing centre were collected from Vellapatti and transported to the shellfish hatchery of CMFRI, Tuticorin. A set of 5 animals each, were maintained for observation on survival, mating and breeding under captivity.
- One set of broodstock animals were held in one tonne FRP tank with airlift recirculation system and macroalgae and another set in 250 l FRP tanks provided with macroalgae and encrusted algal stone boulders.
- Water parameters were monitored and water was changed once in a week (100%). Daily observations for their mating behaviour were made and it was observed that after four months of maintenance, the conch shells in both the broodstock holding system, mated and commenced spawning since November 2009.
- Masses of egg filaments with pale brown colour were laid in the tank bottom and continued for two days. Hatching of egg mass was done in separate tanks and the newly laid egg mass took 5 days for complete hatching.
- Veligers were free swimming and measured about 680 µm. Larvae of conch were reared successfully till 18 day post-hatch (1045 µm) as compared to the rearing of veligers of the same species up to 7 days reported earlier.

Spawning of Conch shells

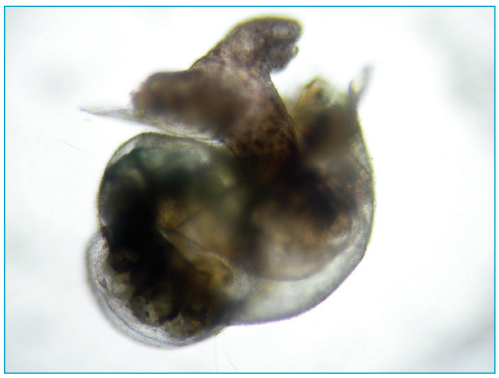
A part of the egg filaments of conch

Sponges

- During the reporting period, surveys were carried out in Palk Bay and Gulf of Mannar to identify suitable sites for the collection of mother stock of some sponge species.
- A rich sponge bed has been observed at Thonithurai (near Pamban) in Palk Bay at Sanghumal and Rameswaram which has a rich sponge resource, dominated by *Spirastrella* sp.
- The mother stock of sponges including *Spirastrella* sp. and *Sigmadocia* sp. were maintained in captivity and the survival of *Spirastrella* sp. was appreciable and mortality rates were very low.
- Explants of two species *viz*., *Haliclona* sp. and *Sigmadocia* sp. exhibited growth initiation within 24 h of fragmentation. In 96 h period, the explants started attaching to the glass substratum. The photomicrographs revealed the presence of sclerites in the region of attachment.



Day 1 veliger of conch



18 day post-hatch larvae of conch

Marine Angels

- Four numbers of sub-adult marine angel species, *Pomacanthus semicirculatus* and *P. annularis* ranging from 15-20 cm and 90 to 130 g were collected from wild and quarantined and stocked at two fishes per two tonne tank and fed @ 10% of the body weight with *Acetes* spp., polycheate worms, fresh sardines and sponges, with regular health and water quality monitoring.
- The broodstock fishes in each tank are separated from each other by a net partition to avoid territorial aggression and to promote conditioning in captivity.

Marine wrasses

- Twelve numbers of sub-adult *Thalassoma lunare* (10-16 cm and 30 to 60 g) and four numbers of *Acanthurus leucosternon* (12-14 cm and 25 to 32 g) were collected from wild and quarantined and fed @ 10% of the body weight with polycheate worms, fresh sardines, enriched adult *Artemia* and artificial feed.

Marine Biotechnology

PROJECT CODE	MBTD/NUT/01
PROJECT TITLE	**Formulation and evaluation of larval and grow out feed for marine crabs, lobsters, ornamentals and cage farmed finfish**
SCIENTISTS	**P. Vijayagopal,** I. Rajendran, Margaret Muthu Rathinam and Kajal Chakraborty
CENTRES	Kochi, Mandapam and Chennai

Marine ornamental fish feed

The marine ornamental fish feed developed has been further refined in terms of packaging and colouring with natural colour sources. The feed named 'Cadalmin™ Varna' has been field tested and showed wide acceptability among aquariculturists.

- Other than co-extruded stand-up pouches (50 g) in which the shelf life is over a year, HDPE containers of 85 g and 50 g capacity which indicated a shelf life of one year were also included in the product array. Insect infestation, mainly ants, due to pores between the caps which have a dispensing option is found to be a drawback. Polypropylene airtight containers with flip-tops are under evaluation.
- Colours were stable without leaching when the feeds were dispersed in Aquarium.
- CMFRI aquaria at Vizhinjam and Kozhikode Research Centres are using the Varna series of feed for routine maintenance.

Packed marine ornamental feeds

Nutrition of cage farmed finfish

Process optimization

- The oily ingredient mix (OIM) which constituted 40% of the formulation was mixed separately and stored at 70 °C. The remaining 60% of the formulation made up of non-oily ingredients and designated as non-oily ingredient mix (NOIM) was mixed separately.

  Assuming the OIM to be moisture free, water addition to the NOIM was calculated as follows:

  Estimated dry matter % in NOIM = 89.76
  % moisture = 10.24
  Moisture % in 1500 g NOIM = 1500 x 10.24/100
  = 153.6 ml

  In order to arrive at the amount of water to be added to get 18% moisture in the final mix

  X + 153.6 / X+2500 = 0.18

  Solving the equation for X, we get 361.5 ml or approximately 362 ml

- The acceptability of these feeds has been good and feeding trials are underway for the growth performance.
- Formulated feeds (40% protein, 5% fat and <4% fibre) for finfish mariculture using extrusion technology. Processes optimized for sinking, slow sinking and floating feeds through twin-screw extrusion for fish rearing in different levels of water columns *i.e.*, surface (floating), column (slow sinking) and bottom (sinking).

Growth performance of spiny lobsters reared in semi-closed recirculatory system for 120 days using formulated pellet feed

		Survival rate %	Total biomass output (g)	Biomass output/day (g)	Avg. W inc (g)	Avg. W inc/day (g)	Avg. CL inc/day (mm)	Avg. CW inc/day (mm)
P. homarus	Male	80	735	6.125	36.75	0.306	0.062	0.035
	Female	88	820	6.833	37.27	0.311	0.056	0.038
	Combined	84	1555	12.958	37.01	0.308	0.059	0.037
P. polyphagus		92	675	5.625	33.82	0.282	0.047	0.027
P. ornatus		92.16	1055	8.792	47.29	0.394	0.066	0.047
P. versicolor		66.7	445	3.708	24.71	0.206	0.049	0.033

- Formulated feed developed for lobster rearing was tested in spiny lobsters. *Panulirus homarus* indicated superior growth over other species and the feed need further refining and testing

Sinking pellet

Slow sinking pellet

Floating pellet

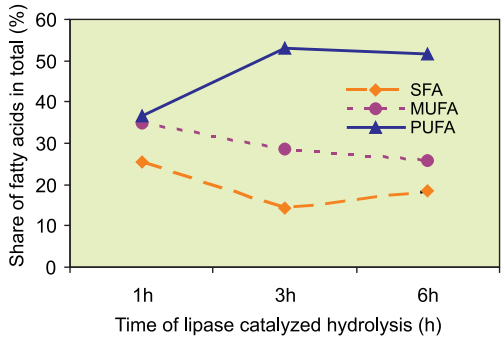
- Ornamental fish feed with natural colours of red, orange, green and yellow are ready for commercialization. The sources of colours are beetroot, paparika and chlorophyll.
- Patent application entitled 'Formulated feed for marine ornamental fishes and a product therefore' No.32/CHE/2010 filed
- The Cadalmin™ *Varna* Series of feeds are routinely used in CMFRI Centers for aquarium rearing facilities and sold through ATIC counter at CMFRI, HQ, Cochin. Analytical support on fish nutrition was provided to different experiments conducted by the Mariculture Division at Mandapam Regional Centre on ornamental fish nutrition and cage culture at Karwar.

Preparation of eicosapentaenoic acid concentrates from sardine oil by *Bacillus circulans* lipase

- The extracellular lipase derived from *Bacillus circulans* isolated from marine macroalga *Turbinaria conoides* was used to prepare *n*-3 polyunsaturated fatty acid (PUFA) concentrates from sardine oil triglycerides. The refined sardine oil was found to contain PUFAs particularly 20:5n-3 (17.62 ± 0.61%) and 22:6n-3 (8.16 ± 0.96%) along with other n-3 and n-6 PUFAs like 18:3n-3 (2.48 ± 0.53%), 20:4n-6 (1.59 ± 0.02%), 18:2n-6 (0.69 ± 0.12%), and 22:5n-3 (1.09 ± 0.15%). The n-3 fatty acids contributed the major share (30.58%) with the n-3/n-6 fatty acid ratio of 13.41. The total saturated fatty acids (SFAs) were recorded to be as 30.03%. Among saturated fatty acids, 16:0 was found to be predominant (18.43 ± 1.96%) followed by 14:0 (8.50 ± 0.16%), and 18:0 (2.14 ± 0.02%).
- Lower hydrophobic constants of *n*-3 fatty acids (18:3*n*-3$_{\log P}$ = 5.65; 20:5*n*-3$_{\log P}$ = 5.85, respectively) than *n*-6 (20:4*n*-6$_{\log P}$ = 6.16) resulted in higher hydrolytic resistance of the former towards lipase leading to their enrichment in the triglyceride fraction.
- The *n*-3 terminal moiety with olefinic part at third carbon atom from the terminal methyl carbon atom hinders lipase-catalyzed hydrolysis. In *n*-6 fatty acids, the *n*-6 terminal moiety without olefinic bond induced lipase-catalytic hydrolysis of triglycerides resulting in their reduced content in hydrolysate fraction.
- The *n*-3 fatty acids due to their lower affinity towards lipase remain in the native form. The triglyceride α-arachidonate - α',

β-diicosapentaenoate with one arachidonic acid (20:4*n*-6) and two eicosapentaenoic acid (20:5*n*-3) hydrolysis by lipase to form fatty alcohol *viz.*, α-hydroxypropyl- α', α-diicosa-5,8,11,14,17-pentaenoate with unhydrolyzed 20:5*n*-3.

- Lipase catalyzed hydrolysis of sardine oil for 3 h followed by urea complexation provided free fatty acids containing 51.29 ± 4.65% 20:5*n*-3. The purified methyl ester of 20:5*n*-3 (68.29 ± 2.15%) from the urea concentrate was attained by chromatography on argentated neutral alumina
- Modification of fats and oils containing PUFAs by lipase may be a process with prospects for enzyme application on a commercial scale. This procedure to concentrate *n*-3 PUFAs by *B. circulans* lipase would contribute to the commercial application of lipase to obtain concentrated *n*-3 fatty acid from lipid sources having higher PUFA concentrations.

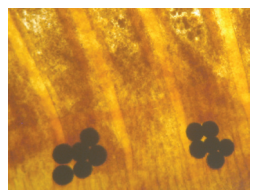


Share of PUFAs with *n*-3 double bond in triglyceride fraction of sardine oil with respect to time duration (1-6 h) of lipase-catalyzed hydrolysis

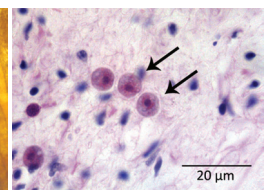
PROJECT CODE	**MBTD/PATH/01**
PROJECT TITLE	**Pathogen profiling, diagnostics and health management in maricultured finfish and shellfish**
SCIENTISTS	**K. K. Vijayan,** P. C. Thomas, K.S. Mohamed, I. Rajendran, K.S. Sobhana, Kajal Chakraborty, N.K. Sanil, M.K. Anil, B. Santhosh, K.N. Saleela, Rekha Devi Chakraborty, Margaret Muthu Rethinam, Joe K. Kizhakudan, Krupesh Sharma, Shubhadeep Ghosh and G. Tamilmani
CENTRES	Kochi, Chennai, Mandapam, Vizhinjam and Veraval

Screening of bivalves of mariculture importance for OIE listed pathogens

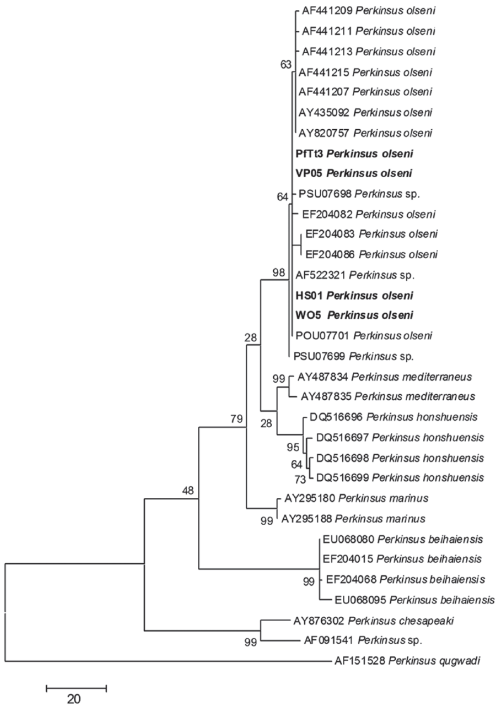
- Pearl oysters (*Pinctada fucata*) from the south-east coast of India were screened for the presence of OIE listed parasites. The tissue samples (gills and mantle) were subjected to Ray's fluid thioglycollate medium (RFTM) culture, stained with Lugol's iodine and examined. Samples were found positive for *Perkinsus* infection.
- Histopathological studies showed *Perkinsus*-like organisms measuring 4.7 µm to 7.3 µm in the infected tissues. DNA based studies were conducted to confirm the histopathological observations of *Perkinsus* sp. in the tissues. Genus specific Internal Transcribed Spacer sequences (ITS) 85 & 750 primers were selected and used for PCR amplification. Primers amplified the ca 700 bp product of *Perkinsus*, confirming the presence of *Perkinsus* infection in the Indian pearl oyster population.
- In order to confirm the species of the *Perkinsus*, molecular taxonomy techniques were employed. The sequences were analyzed using BLAST and the results showed 99% identity to *P. olseni* with 100% query coverage, confirming the taxonomic identity of the parasite as *Perkinsus olseni*, an OIE listed pathogen of bivalve molluscs across the world.
- Phylogenetic analysis was done by aligning the ITS sequences of *Perkinsus* sp. obtained from *P. fucata* with the various available *Perkinsus* sequences from the GenBank. The pair-wise genetic distance between the present isolate and other members of the



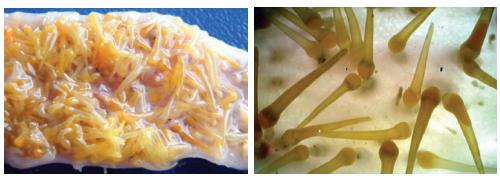
Perkinsus hypnospores in mantle tissues



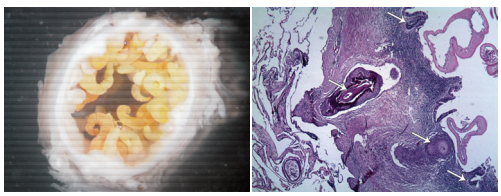
Trophozoites of *P. olseni* in connective tissues



Phylogenetic relationships of *Perkinsus olseni* using maximum parsimony analysis



Acanthocephalan parasites attached to the wall of the intestine of *Lutjanus argentimaculatus*



Cross section of the intestine showing the worm load and narrowing of the intestinal lumen

Histopathology of the intestine showing the destruction to the intestinal tissues by the attached parasties

P. olseni group studied, was very low, indicating its affiliation to the *P. olseni* clade. The maximum parsimony and neighbor joining analysis of the nucleotide sequences of the ITS region of the present parasite further confirmed its identity as *Perkinsus olseni*. The sequence information generated was submitted to NCBI database (GenBank), Accession Nos. GQ896504, GQ896505, GQ896506 and GQ896507.

- Considering the importance of red snapper (*Lutjanus argentimaculatus*) for mariculture in India, fishes were screened to assess the health status of the wild fish population. High levels of acanthocephalan infection in the intestine and myxosporean infection in the gall bladder were recorded. Acanthocephalan parasites were found attached to the posterior region of the intestine with its spiny proboscis embedded deep within the intestinal wall. The parasite showed a prevalence of 100% and the intensity of infection varied from moderate to very heavy. Histopathological studies revealed severe damage to the wall of the intestine due to the attachment of the heavily armed proboscis. The parasites were seen almost filling the intestinal lumen and could seriously affect the quality of the broodstock and thereby hatchery production of seeds.

Treatment of bacterial infections in seabass reared in open sea cages

- Seabass young ones reared in open sea floating cages off Vizhinjam showed symptoms such as erythemia and mild ulcerations all over body surface. The feed was top coated with a combination of chloramphenicol + Oxytetracycline (1:0.5 ratios) in gelatin and administered to the seabass. Complete recovery was noted from the fourth day of treatment indicating the possibility of combating bacterial infections.
- Screened potent antimicrobials from the sponge, *Callyspongia subarmigera* (Ridley) against fish and shellfish pathogenic bacteria. The methanol extracts of *C. subarmigera* inhibited the fish and shellfish pathogenic bacteria such as *Vibrio alginolyticus, V. pelagius*, *V. harveyi*, and *Pseudomonas aeruginosa* at 0.1% of the extract onwards.

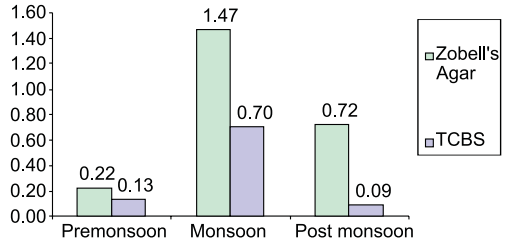
Microbial abundance in a broodstock rearing tank, a case study on spiny lobster, *Panulirus homarus*

- Study was undertaken to investigate the diverse bacterial community during various months. Water and sediment samples were collected from the *Panulirus homarus* rearing tanks at regular intervals to assess the microbiological quality. Water quality parameters monitored regularly revealed temperature 28±1 ^{0}C, pH ranged between 7.0 and 7.8 and salinity 28-32 ppt. Production of chitinase was found highest in vibrios (50%) and DNase in *Bacillus* (92%).

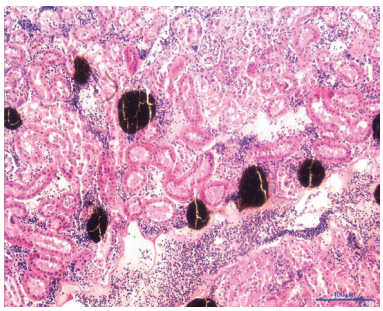
Pearl oysters (*Pinctada fucata*) found infected with *Perkinsus olseni*, an OIE listed protozoan parasite with a prevalence of 100% could be one of the major reasons for the decline of the natural pearl oyster beds along the Tuticorin coast, south-east cost of India.

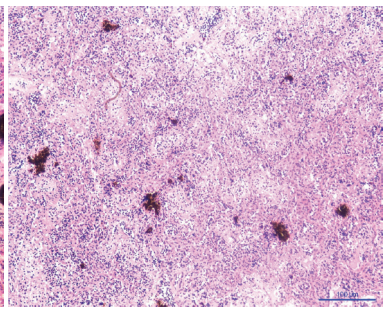
Bacterial abundance

- During March-May the bacterial load in the rearing tank recorded the lowest value for both THB and TCBS as 0.22 x 103 cfu/ml and 0.13 x 103 cfu/ml of water respectively. The highest value recorded was during July-August with a mean value of 1.47 x 103 cfu/ ml and 0.7 x 103 cfu/ ml respectively. September-October recorded a slightly lesser value of 0.72 x 103 cfu/ ml and 0.09 x 103 cfu/ ml for THB and TCBS respectively.
- The bacterial diversity studies on the rearing tank indicated that the most predominant microbial genera were *Pseudomonas* (70%) followed by *Bacillus* (13.0%), *Vibrio* (9%), *Enterobacteriaceae* (5%), *Coryneformes* (2%) and *Micrococcus* (1%).
- The results of the antibiotics assay studied showed that almost all the isolates were sensitive towards chloramphenicol and gentamycin. With ampicillin, 100% of *Coryneformes*, 40% of *Enterobacteriaceae,* 29.68% of *Pseudomonas*, 25% of *Vibrio* and 16.66% of *Bacillus* showed resistance.
- Diseased Cobia (*Rachycentron canadum*) showing anorexia, frequent surfacing, petechial haemorrhages on the skin, pale gills, erosion of gill lamella and fluid accumulation in the peritoneal cavity was subjected to microbiological as well as histopathological investigations. *Vibrio alginolyticus* was isolated from the kidney of diseased specimen. Histological lesions exhibited massive necrosis and sloughing of tubular epithelial cells into the lumen of kidney tubules and presence of large number of melanomacrophage centres (MMCs) in the kidney as well as spleen.



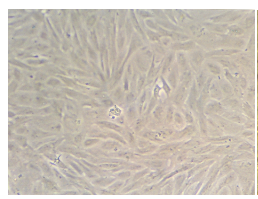
Bacterial diversity in the rearing tanks

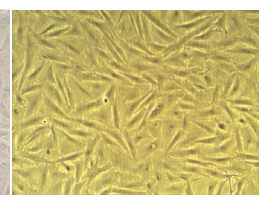

Kidney pathology in diseased cobia

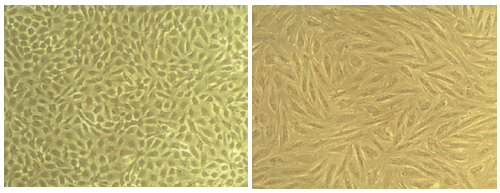

Histological section of spleen of diseased cobia

Development of cell lines

- Out of the 5 cell culture systems developed from *Epinephelus malabaricus*, two (Em3GEX from gill explants and EM4SpEx from spleen explants) have crossed 100 passages. EM2GEx developed from gill explant has crossed 95 passages. EM4SpEx and the EM2GEx are showing characteristics of transformed cell lines with good split ratio, very low serum requirement (2% FBS) and good revival rate after cryopreservation. EM2HTr derived from trypsinised heart tissue, is still very slow growing even at 20% FBS and has reached only up to 30 passages. EM4HTr from heart tissue was lost due to microbial contamination.


EM4SpEx


EM2GEx



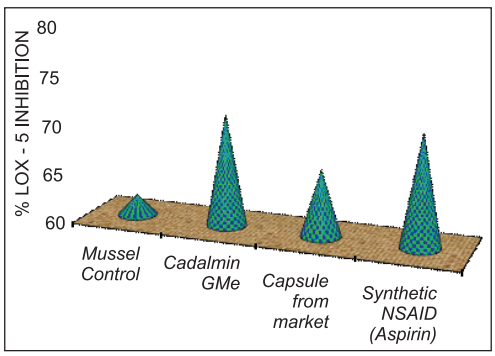
EM3GEx EM2HTr

Details of the cell culture systems developed from *E. malabaricus*

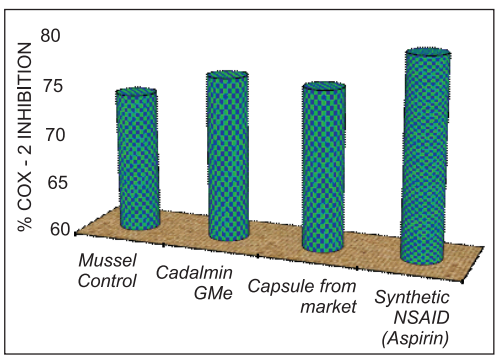
Code No.	Tissue of origin	No. of passages
EM3G Ex	Gill explant	102
EM4Sp Ex	Spleen explant	105
EM2G Ex	Gill explant	95
EM4H Tr	Tryspinised heart tissue	30

Marine Bioprospecting

Green Mussel extract (GMe): A natural alternative to synthetic non steroidal anti-inflammatory drugs



Cadalmin™ GMe - LOX - 5 Inhibition assay

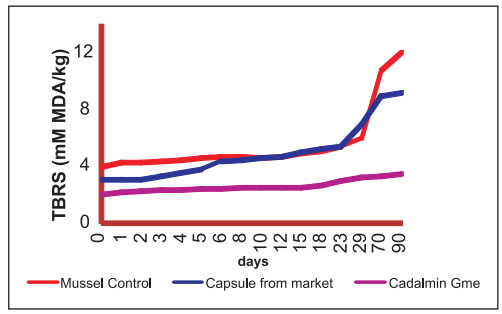


Cadalmin™ GMe - COX - 2 Inhibition assay

- Isolated anti-inflammatory principles in an enriched form from *P. viridis* to prepare stabilized formulation to control arthritis/ inflammatory joint pains. The anti-inflammatory formulation has been further supplemented with 100% natural additives having anti-inflammatory and antioxidant activities to add value to the active formulation and to increase shelf life. The stabilized formulation was found to be significantly more effective than a nonstabilized one to produce anti-inflammatory active ingredients. Green mussel exract's glycogen complex suppresses the inflammation by blocking neutrophil emigration.
- Optimum balance of PUFAs inhibits the activity of leukotriene and cyclo-oxygenase associated with inflammation and mucopolysaccharides relieve arthritic symptoms by enhancing joint lubrication, boosting shock resistance and rebuilding cartilage. Betaine, iron and glycosaminoglycans have direct effect on inflammation and arthritis. Marine minerals aid in body metabolism, water balance, and bone health.
- Green mussel extract was found to inhibit the following inflammatory enzymes and molecules : pro-inflammatory prostaglandins and thromboxanes by inhibiting cyclooxygenase, inflammatory lipooxygenase responsible to form leukotrienes from arachidonic acid and inflammatory cytokine (IL-1β) production.
- Green mussel contains three major components that have been identified as being responsible for joint health benefits : the n-3 fatty acids, glycosaminoglycans (GAGs) and phosphorylated glycogen and phospholipidic components.
- *In vitro* studies revealed that the reactive species that are produced in excess during the inflammatory processes are suppressed by inhibiting inflammatory enzymes (cyclooxygenase-II, and lipoxygenase-V).
- Cadalmin™ GMe is designed to find a unique way to prevent the degradation by air, moisture, heat and light and to maximize the activity. A unique combination of naturally derived compounds was used to impart shelf-life stability. An accelerated shelf-life studies with Cadalmin™ GMe revealed the stability of the target anti-inflammatory principles for three years.
- In general, the lipidic substances originated from *P. viridis* are potentially vulnerable for lipoxidation by several biocatalysts and other molecules resulting in formation of deleterious free radicals and trans fatty acids in the formulation. These potentially harmful products which may build up in the human system if consumed for a

long period, often go unnoticed. Therefore, these high lipidic substances need to be stabilized to combat unwanted harmful principles, thereby protecting the consumers from being affected adversely.

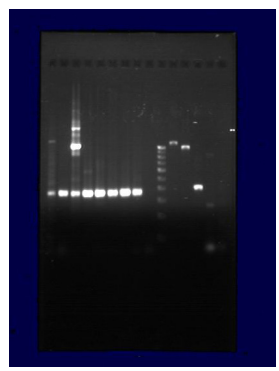
- Cadalmin™ GMe possesses an optimum balance of the essential polyunsaturated fatty acids and amino acids. The n-3 polyunsaturated fatty acids supplemented in a concentrated form in Cadalmin™ GMe induces high nutritional benefit in addition to the target anti-inflammatory action.
- Most bioavailable to the body are the long-chain fatty acids such as eicosapentaenoic acid and docosahexaenoic acid which are important for neurological function, as well as the production of anti-inflammatory eicosanoids, including prostaglandins and leukotrienes. The essential amino acids *viz*., lysine, methionione and taurine are important constituents of Cadalmin™ GMe.
- Cadalmin™ GMe contains broad spectrum of nutrients (proteins, polypeptides, amino acids, naturally chelated minerals like Zn, Cu, Mn), enzymes, antioxidant vitamins (E and C), chondroitin sulfates, polysaccharides and sterols.



Accelearted lipid peroxidation study of Cadalmin GMe for a period eq to 3 years

PROJECT CODE	**MBTD/BIOT/02**
PROJECT TITLE	**Biotechnological applications in mariculture and conservation**
SCIENTISTS	**P.C. Thomas,** K.K. Vijayan, Srinivasa Raghavan and G. Tamilmani
CENTRES	Kochi and Mandapam

- Bar coding of two species of tunas namely *Sarda orientalis* and *Thunnus tonggol* was carried out through PCR amplification of CO-1 gene followed by sequencing. The CO1 sequence information of these two species along with that of 5 species bar coded during last year (*Auxis rochei, Auxis thazard, Katsuwonus pelamis, Thunnus albacares, Euthynnus affinis*) have been deposited in NCBI and FISH-BOL data base (Accession No.GQ199626 to GQ 199630 and GU190377 to 378).
- In the case of the Dogtooth tuna, *Gymnosarda unicolor*, repeated barcoding using CO1 gene could not confirm the species identity with reference to the classical taxonomy. The sequence data did not match the NCBI Gen Bank with *Gymnosarda unicolor.* The ambiguity could be due to the insufficient data available at the Gen Bank or possible identification problem through the traditional taxonomy method. To clarify the taxonomy, bar-coding is being done by the amplification of Cytochrome–b gene.
- Characterization of the functional genes involved in stress tolerance and disease resistance *viz.*, heat shock protein (*hsp 70* and *hsc 72)*, Cathepsin (*cathL*), Leucine aminopeptidase (*lap*) and the genes involved in pearl formation were carried out.



hsc 72 of *P. indica*

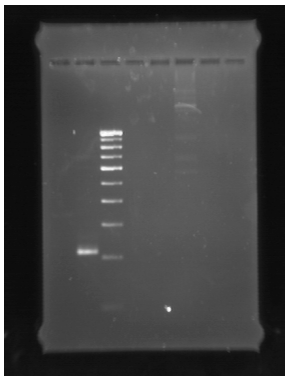
1. Heat shock protein gene

- Hsp is involved in the stress tolerance mechanism. While the hsc 72 is a constitutively expressed gene, hsp 70 is stress inducible.

a) Brown mussel hsp

Presence of *hsc 72* in *Perna indica* could be identified through PCR amplification of the genomic DNA of *P. indica* specific primers.

Transcriptomic analysis for confirmation of the constitutive expression of *hsc 72* was also carried out. The full length coding region of *hsc 72* was PCR amplified as two partial segments (1110 bp and 1000 bp), from the cDNA template generated from the mRNA, using two sets of specially designed primers. The 1000 bp amplicon was sequenced, aligned and deposited with NCBI (Gen Bank accession number: GU 91233)



cathL of *C. madrasensis*

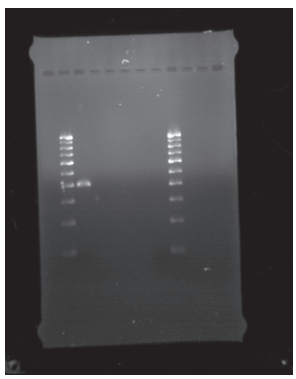
2. Cathepsin gene (*cath L*)

Cathepsin is a lysosomal cysteine protease involved in various immune functions- antigen processing, phagocytosis and cleaving of pro-enzyme to release the functional antimicrobial enzyme. Cathepsin gene in *C. madrasensis* could be identified through PCR amplification of the gene using cathepsin specific primers. Expression of *cath L* in *C. madrasensis* was confirmed from the PCR amplification of the partial coding sequence using cDNA templates generated from the mRNA using specific sets of primers.

3. Leucine aminopeptidase gene (*lap*)

lap is a peptidase with role in growth and development, stress response and adaptation to changing environmental conditions.

Presence of *lap* in oysters was established through PCR using *lap* specific primers. Transcriptomic analysis for confirmation of the expression of *lap* by *C. madrasensis* was carried out by the PCR amplification of the partial coding sequence of *lap* using cDNA templates generated from the mRNA using specific sets of primers.



lap of *C. madrasensis*

4. Pearl oyster genomics

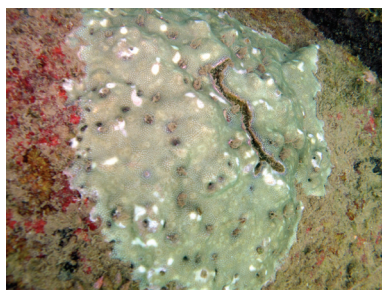
- Characterization of the nacrein gene involved in pearl formation was undertaken. Nacrein specific primers were designed and custom synthesized. Expression of nacrein gene in *Pinctada fucata* was confirmed through the transcriptomic analysis.
- Total RNA containing mRNA transcribed from the nacrein gene was extracted. cDNA was synthesised by RT-PCR from the mRNA fraction of the total RNA.
- PCR amplification of cDNA of the nacrein gene using gene specific primers yielded 144 bp amplicon.
- Characterization of the other genes controlling the bio-mineralization process involved in pearl formation has also been initiated. Primers specific for the calreticulin and prismalin genes have been designed from the ESTs of the related species and their characterization is in progress.

Marine Biodiversity

PROJECT CODE	MBD/RE/01
PROJECT TITLE	**Understanding the threatened coral reef ecosystems of southern India and designing interventions aimed at their restoration**
SCIENTISTS	**Mary K. Manisseri,** Rani Mary George, V.S. Kakati, K.K. Joshi, Molly Varghese, K. Vinod, Sujitha Thomas, T.S. Naomi, S. Jasmine, Rekha J. Nair, Miriam Paul Sreeram, Sandhya Sukumaran, K.S. Sobhana and P.S. Asha
CENTRES	Kochi, Vizhinjam, Mangalore, Karwar, Tuticorin and Mandapam

- Underwater surveys were conducted following Line Intercept Transect Method along the coasts of Muttom, Enayam, Vizhinjam and Quilon to collect information on the present status of coral cover and biodiversity. The coral growth was patchy and sparsely distributed. In the Thankassery Harbour area, both *Pocillopra damicornis* and *Pocillopora verrucosa* were recorded. A single species, *Porites lutea* was dominant at Thirumullavaram, where it was observed that diseased corals were predominant and the live coral cover was less than 50%. Rich assemblages of marine ornamental fishes were observed, especially at Thirumullavaram temple point, Thankassery Harbour, Paravoor, Odayam, Varkala, Vizhinjam and Enayam waters.
- Pink Line Syndrome was found to be prevalent among the *Porites* sp. at Thirumullavaram. In some cases, pigmented spots appeared as small raised pink areas surrounded by healthy tissue and in other cases as pink lines or rings bordering dead patches.

Bleached *P. damicornis* from Thankassery Harbour area



Porites Ulcerative White Spot Syndrome (Vizhinjam Bay)

- Occasional incidence of bleached *P. damicornis* among algal settlement and sedimentation was recorded at Thankassery Harbour area. At Enayam, *Porites* spp. affected by Pink Line Syndrome and/or infested with boring organisms as well as infestation with algae were noticed. At Vizhinjam Bay, *Porites* Ulcerative White Spot Syndrome along with infestation of boring organisms was recorded.
- Field surveys were carried out in the Palk Bay and Gulf of Mannar for understanding the distribution and availability of sponge resources. Abundant sponge resources, predominated by *Spirastrella* spp. have been found between Thonithurai and Koilvady. Quadrat sampling conducted at Chinnapalam indicated distinct zonations of different types of sponges. Studies conducted at Thiruppalaikudi and Devipatnam areas revealed damage to the sponge resources caused by minitrawl (*Thallumadi*) and bottom set gillnet (*Nandu valai*)

- 'Pink Line Syndrome' and '*Porites* Ulcerative White Spot Syndrome' are reported in hard corals at Thirumullavaram and Vizhinjam Bay, respectively.
- Anthiinid fish, *Pseudanthias fasciatus* (Kamohara, 1954) is reported for the first time from Indian waters.

Pink Line Syndrome in *Porites lutea* from Thirumullavaram, Quilon

Rich sponge beds at Thonithurai

operations. Twenty one species of sponges were collected off Vizhinjam. Sclerites were extracted from six different parts of the samples using chemical treatment. The sclerites were studied and measurements taken to record the taxonomic status and specieswise distribution of sponges in the habitat.

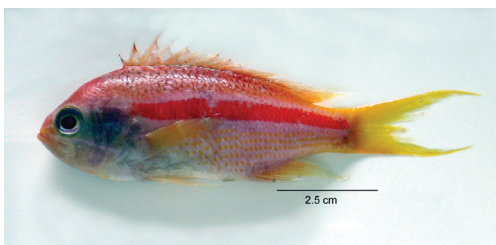
- Underwater transect survey (GPS based) conducted at three sites (Lobster Avenue, Chow Point and Jetty) in Grande Island, Goa showed rich coverage of corals around the island. The total area of coral cover at Site I was about 9,000 sq m, at Site II, 14,000 sq m and at Site III, 2,000 sqm, respectively. At all the sites *Turbinaria* sp. dominated, followed by *Porites* sp. Underwater visual transect was done for finfishes and the fish density at each site was analysed. Finfishes belonging to 17 families were recorded. Balistidae family dominated at Site I and III, while at Site II Pomacanthidae dominated. The diversity indices were calculated for the three sites. In line with the abundance and number, Shannon diversity indices (H') were 2.2 at Site III and 2.0 at Site II. The evenness (J') of species distribution was more at Site II (0.9), followed by Site III (0.8) and Site 1 (0.7).

Lobophytum crassum planted for propagation

- Collections were made of soft corals and sponges by Scuba diving from Thankachimadam in the Palk Bay. One species of *Lobophytum* and three species of *Sinularia* were observed. Live colonies of two genera of soft corals were brought and maintained in the hatchery at the Headquarters for culture experiments through fragmentation technique. *Lobophytum crassum* got attached to the substrata provided and showed growth from the cut portion. The young colonies were transported to Mandapam Regional Centre for further experimental studies and propagation.

L. crassum showing growth of new lobes from the cut portion in 6 months

- The anthiinid fish *Pseudanthias fasciatus* (Kamohara, 1954) is reported from the Indian waters for the first time. These fishes were collected from the trawler bycatch landed at the Neendakara Fisheries Harbour near Kollam (09°41'18.28" N, 76°33'05.89" E), Kerala on 24.02.2006. The specimens described are deposited in the Designated National Repository for marine organisms at CMFRI Headquarters with the Accession Number GB.31.139.44.18.



Female specimen of *Pseudanthias fasciatus* (Kamohara, 1954) landed at Neendakara

- A total of 72 species of coral reef fishes were collected and identified from different centres at Tuticorin. Out of the 72 species identified, 30 species contributed to ornamental fishery, 26 were used mainly for human consumption and 16 for preparation of fishmeal and other uses. Estimated total catch of species showed a wide variation from 3 kg to 19.2 t annually. Most abundant groups of coral reef fishes belonged to barracuda (Sphyraenidae), goatfish (Mullidae), wrasse (Labridae) and

triggerfish (Balistidae). The fishes of the family Chaetodontidae (butterflyfish) were the most diverse group which consisted of 10 species and all the species were ornamental fishes of high demand.

Epinephelus flavocaeruleus from Keelakarai

- Coral reef fishes landed at Pamban, Mandapam and Keelakarai from the Gulf of Mannar were monitored. A total of 163 species belonging to 49 families were recorded from this area. The number of species as well as quantity were high at Pamban where the landing was by trawl net. The major components of the fishery were *Lethrinus* spp. (26.89%) and *Caranx* spp. (10.94%). At Keelakarai, traps are being operated throughout the year. The major fishery was contributed by *Siganus* spp., *Scarus ghobban*, *Lethrinus* spp. and *Epinephelus* spp.
- Vertical and horizontal transects were conducted at Polem Beach to record the intertidal flora and fauna. A clear vertical zonation was observed with the upper region dominated by gastropods and barnacles. This was followed by a partially submerged zone with oyster spats and zooanthids. The zone which followed this area was dominated by brown and green algae, the dominant fauna being gastropods. *Saragassum* spp. was found in the completely submerged zone.
- Biodiversity of crabs and other crustaceans in the intertidal coral reef areas of Gulf of Mannar and Palk Bay was studied. Twentyfive brachyuran crabs, one anomuran crab and 3 species of hermit crabs were collected. From the net cage installed off Mandapam, one berried anomuran crab *Porcellana picta* was collected.
- The numerical density of sea cucumber *Holothuria atra* at Pamban Island varied from 0.01 to 0.02 no/m^2 with a biomass ranging between 1.53 to 1.8 g/m^2. *H. atra* showed variation in its habitat preference. Coral stone appeared to be the preferred habitat followed by seaweed and seagrass beds.
- In the trawler discards at Pamban, the dominant species of echinoderm was *Salmacis virgulata* (38.7 %). Sea urchins landed were mostly broken. Colour and morphological variation were high in *Pentaceraster* spp. At Neendakara, sea stars and cake urchins were present in the trawler discards in minor quantities.
- A total of 87 species of macroalgae were collected during three surveys conducted in the Gulf of Mannar and Palk Bay along the south-east coast of India and photographs of the fresh specimens were taken for preparation of posters. Herbarium of all the species have been prepared and deposited in the Designated National Repository at CMFRI Headquarters. Colour preservation of the seaweeds has also been attempted.

Seaweed *Caulerpa taxifolia*

PROJECT CODE	**MBD/RE/04**
PROJECT TITLE	**Species variation and biodiversity of the fishes of the family Lutjanidae of India**
SCIENTISTS	**K.K. Joshi,** Rani Mary George, T.S. Naomi, S. Jasmine, Molly Varghese, Rekha J. Nair, Miriam Paul Sreeram and Sujitha Thomas
CENTRES	Tuticorin, Mandapam, Vizhinjam, Kochi, Karwar and Mangalore

- A total of 31 species of fishes of the family Lutjanidae were collected from the landings by different gears at selected centers.
- Fishes of the family Lutjanidae recorded belong to 8 genera and maximum diversity was observed in the genus *Lutjanus* (21 species)

Lutjanus lutjanus Bloch, 1790

followed by *Pristipomoides* (4). Monotypic genera are *Aprion, Etelis, Lipocheilus, Paracaesio* and *Pinjalo*. Most of the species recorded are commercially important and beautifully coloured.

- Maximum number of species was recorded from Cochin (22) followed by Mandapam (16), Tuticorin (16), Vizhinjam (12) and 9 each from Karwar and Mangalore.
- Among these, the most abundant and common species are *Lutjanus argentimaculatus, L. bohar, L. fulviflamma, L gibbus, L. johnii, L. russellii, Pinjalo pinjalo* and *Pristipomoides filamentosus.* Less abundant and rare species are *Aphareus rutilans, Aprion virescens, Etelis carbunculus* and *Paracaesio sordida.*
- Detailed information on the distribution, synonyms, morphometric, meristic and biological characteristics and taxonomic details of all the 31 species were collected.

Lutjanus russellii (Bleeker, 1849)

Lutjanus gibbus (Forsskal, 1775)

Lutjanus quinquelineatus (Bloch, 1790)

PROJECT CODE MBD/RE/05

PROJECT TITLE Assessment of biodiversity and ecological changes in open sea farming

SCIENTISTS **K. Vinod,** Rani Mary George, V.S. Kakati, Molly Varghese, Sujitha Thomas, S. Jasmine, Miriam Paul Sreeram, K.K. Philippose, R. Narayanakumar, M.K. Anil, A.P. Dinesh Babu, A.K. Nassar, B. Santhosh, Krupesh Sharma, Bindu Sulochanan, M. Sakthivel and K. Kalidas

CENTRES Mandapam, Vizhinjam, Kochi, Mangalore and Karwar

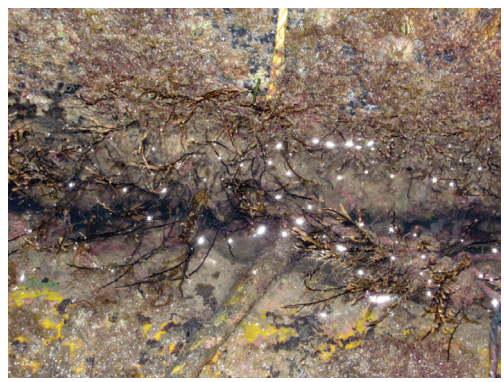
- At Mandapam, three circular cages of 6 m diameter were launched at 800 m from the shore. The outer and inner rings of the cage were fitted with HDPE nets of stretched mesh size of 60 and 30 mm respectively.
- The cage farm has one broodstock cage for Cobia (*Rachycentron canadum*) and another for Pompano (*Trachinotus blotchii*) as well as a rearing cage for Seabass (*Lates calcarifer*). A control site with similar depth characteristics was identified 1 km away from the cage farm site in the Gulf of Mannar for studies on the ecology and biodiversity.
- Studies on water quality parameters, sediment, plankton and benthos were initiated in November 2009. Salinity varied from 28.5 to 33.2 ppt and 28.5 to 33.4 ppt; pH values from 7.92 to 8.1 and 7.94 to 8.5 and values of dissolved oxygen from 4.28 to 5.5 ml l^{-1} and 4.59 to 5.6 ml l^{-1} in the cage farm and control site respectively.
- Total suspended solids (TSS) ranged from 31.6 to 46.2 mg l^{-1} and 32.4 to 46.4 mg l^{-1}, and chlorophyll *a* values from 0.4724 to 2.58 mg m^3 and 0.2694 to 4.0414 mg m^3 in the cage farm and control site respectively. The textural analysis of sediment revealed a higher percentage of sand grains in all the tested samples.

A view of the cage farm site in Gulf of Mannar

- Studies on fouling in the seabass cage net at Villundi (Palk Bay) showed that barnacles were predominant forming a complete mat on the cage net. The average number of barnacles in one sq. m. area of the net was 8315 nos., while the same for oysters was 9.7. The average wet weight of the net infested with barnacles and oysters was 9.17 kg per sq.m. The vertical profile of fouler infestation was also observed.
- The fouling organisms observed on the cobia cage nets included barnacles, pearl oysters, edible oysters, ascidians, sponges and crabs.
- The fouling organisms observed on pompano cage nets were barnacles, edible oysters, seaweeds and sponges. The entrant fishes were silverbellies (*Leiognathus daura*), lion fish and banner fish, besides lobsters, shrimps and crabs.
- In Karwar Bay, two cages and three rafts were installed. *Mugil cephalus* was introduced in one cage and two rafts and *Lates calcarifer* in the other cage and raft.
- The fouling organisms observed on the cage nets were *Perna viridis*, *Crassostrea madrasensis*, barnacles, seaweeds and *Modiolus* spp. Heavy fouling by mussels observed on the cages during October-December coincided with the spat settlement time of *Perna viridis*.
- The miscellaneous species collected from the cage included *Scatophagus argus*, *Sillago sihama*, *Thryssa mystax*, *Penaeus merguiensis*, *Metapenaeus monoceros* and *Grapsus albolineatus*.
- The microbial load in the surface water ranged from 2.6 x 10^3 to 8.5 x 10^3 CFU ml^{-1} (gram negative cocci and rods), while at 4m it was 1.96 x 10^6 CFU ml^{-1} and in the bottom at 8m it varied from 7.4 x 10^3 to 5.5 x 10^4 CFU ml^{-1} (gram negative rods and long chains). In the sediments, the concentration of microbes was from 3 x 10^3 to 4 x 10^5 CFU ml^{-1} (gram negative rods and long chains).
- Off Mangalore, a cage was installed at Uppunda, Byndoor, Karnataka in January 2010 (13°52'212"N & 74°36'647" E).
- The hydrography at the cage and control sites was studied. The salinity was 35 ppt, pH 8.31 and dissolved oxygen 6.9 mg l^{-1} in the surface water samples at the cage as well as control sites. The chlorophyll *a* concentration (mg m^{-3}) was 0.2233 and 0.1798 mg m^{-3} at the cage and control sites respectively.
- For fouling studies, panels of 10 x 10 cm were suspended from the cages at different depths. Observation after one month period showed settlement of algal matter on the panels. Wild fish aggregation was seen around the cages which included *Terapon jarbua* (60%), *Siganus canaliculatus* (12%), *Caranx* spp. (12%) and *Sardinella longiceps* (16%).

Counting of the fouling organisms in cage nets using quadrat

Oysters and barnacles on cage nets



Seaweeds attached to the pipes

Socio-Economics and Extension

PROJECT CODE	SEE/PEM/01
PROJECT TITLE	**Benefit-cost analysis of marine fishery business and alternative investment options**
SCIENTISTS	**R. Narayanakumar,** R. Sathiadhas and N. Aswathy and Shyam S. Salim
CENTRE	Kochi

Fish marketing at Karwar

- At Karwar**,** most of the trawl boats in the harbour are bringing trash fishes consisting of stomatopods and other low value fishes fetching Rs.1,000 to Rs.2,000 per tonne, which are transported to Mangalore for making fish meal, poultry feed and manure.
- The average operating cost per trip of a single day purse seiner worked out to Rs. Rs.14,481 earning a gross revenue of Rs.25,455. The capital productivity worked out to 0.56. All purse-seine boats use the GPS facility
- The average initial investment of a single day purse seiner ranged from Rs.40 lakshs to Rs.50 lakh, much higher than that of the investment in a single day trawler, which ranged from Rs.5 lakh to Rs.10 lakh. The average economic life of the craft ranged from 10 to 12 years.
- The average operating cost of a multiday trawler (of less than six days duration) worked out to Rs.76,108 at Versova in Maharashtra with an average gross return of Rs.1,30,232. The operating ratio (capital productivity) worked out to 0.58.
- The average operating cost per trip of a MDF trawler (>6 days) ranged from Rs.73,485 at Sassoon dock to Rs.75,948 at Versova in Maharasthra. The gross revenue per trip ranged from Rs 124398 at New Ferry Wharf to Rs.1,38,794 at Versoa.
- The capital productivity was most efficient in the MDF trawler (>6 days) at Versova with the lowest operating ratio of 0.55 against the operating ratio of 0.58 at Sasoon dock and 0.69 at New Ferry Wharf
- In multi-day trawl fishing of 2-5 days duration in Andhra Pradesh, the capital resource use was efficient in Kakinada with a lower operating ratio of 0.42 against 0.58 at Bhairavapalem.
- For the multi-day trawl fishing of 5-10 days duration, the capital productivity was efficient in Andhra Pradesh with lower operating ratios of 0.33 and 0.63 at Kakinada and Bhairavapalem
- The operating ratio (capital productivity) worked out to 0.74 at Munambam Fisheries Harbour, 0.69 at Sakthikulangara, 0.73 at CFH and 0.55 at Beypore in Kerala.

Gillnet and purseseine fishing

- The average operating cost per trip of a multiday gillnetter worked out to Rs 65820.30 per unit with an average gross return of Rs.86485 at Satpati in Thane. The average operating ratio was 0.76.
- The average operating cost per trip of a multiday purse seines operation worked out to Rs.19,600 at Mirkarwada in Ratnagiri against an average gross return of Rs.33,250 per trip. The operating ratio worked out to 0.59
- The average operating cost per trip of purse seiner operating MDF (2-7 days) at Goa, worked out to Rs.1,25,182 and the gross revenue

realized worked out to Rs.2,12,594 per trip. The operating ratio worked out to be 0.59. At Goa, most of the purse seine boats undertook multiday fishing trips of two to seven days duration.. They are of 52 to 65 ft overall length with engine capacities ranging from 98 to 160 hp. The crew size varied from 25 to 35 members.

Dol netter

- The average operating cost of a multiday dol netter operation from Naigaon in the coastal district of Thane, worked out to Rs.67560.30 per unit with an average gross return of Rs.92.548. The average operating ratio worked out to be 0.73
- The average operating cost per trip of a single day dol netter operation from Kalamb in Thane, worked out to Rs.964 with an average gross return of Rs.1,338.. The average operating ratio worked out to be 0.72
- For a single day dol netter operation landing centre of Arnala in the coastal district of Thane, the average operating cost worked out to be Rs.1,870 per unit with an average gross return of Rs.5,698. The average capital productivity ratio worked out to be 0.33.

Karwar Landing Centre

Marine fish marketing

Market structure

In Karwar, Karnataka, three marketing channels exist for marine fish namely,

- Fishermen- Auctioneers - Retailers - Consumers
- Fishermen- Auctioneers - Commission agents - Wholesalers -Retailers - Consumers
- Fishermen - Auctioneers - Agents of exporter s- Processor -Exporters - Consumers
- Premium varieties like shrimps and cephalopods are mainly sold for the export sector. The export price is fixed once in every fortnight based on the agreement between the trawl owners union and agents of exporters.
- The varieties like flat fishes, crabs, mackerels and seer fishes are mainly transported to whole sale markets in Northern and central Kerala through the agents. There are nearly 20 local purchase agents in the centre. In addition 8-10 commission agents of wholesalers from Kerala and Goa are operating in the harbour.

Loading of fish for internal marketing

Price behaviour

- At macro level, analysis of fish price behaviour at landing centre and retail levels for the year 2009 showed that the average minimum annual price was recorded for oil sardine at Rs. 20 per kg and the maximum for white shrimps (*P. indicus*) at Rs.300 per kg. At retail level, the minimum price was recorded for oil sardines at Rs.31 per kg and the maximum price was recorded for pomfrets at Rs. 450 per kg.
- At Karwar, the average landing centre prices ranged from Rs.11 per kg for oil sardines, Rs. 22 per kg for mackerels (medium sized) and Rs. 45 per kg for large sized mackerels to Rs.75/kg for big sized mackerels and Rs.130/kg for *M. monoceros*. At retail market level the prices ranged from Rs. 38 per kg for medium sized oil sardines to Rs. 400 per kg for large sized pomfrets.

- At Mumbai, for varieties like pomfrets, seer fish, cephalopods and shrimps the fishermen earned more than 75% of the consumer rupee, which indicated an efficient marketing system. The lesser pelagic varieties also earned more than 65% of the consumer rupee to the fishermen during 2009-2010.
- At Kakinada and Bhairavapalem markets of Andhra Pradesh, the landing centre price ranged from Rs.12/kg for silverbellies to Rs.160/kg for medium sized penaeid prawns. At the retail market level, the price ranged from Rs.17 per kg for silver bellies to Rs.170/kg for penaeid prawns. Varieties like penaeid prawns (95.24% of the consumer rupee), sharks (94.5%), pomfrets (93.75%) and seer fish (90.32%) gave more than 90% of the consumer rupee to the fishermen indicating an efficient marketing system existing for these premium varieties.

PROJECT CODE SEE/PMS/01

PROJECT TITLE **A diagnostic study on dimensions, causes and ameliorative strategies of poverty and marginalisation among the marine fisher folk of India**

SCIENTISTS **C. Ramachandran,** R.Sathiadhas, V.P. Vipinkumar and P.S. Swathilekshmi

CENTRES Kochi, Visakhapatnam, Mangalore and Chennai

- The data collection using the PPAR approach, which was designed and validated in 2008-09, was continued in Kerala, Tamil Nadu, Andhra Pradesh and Karnataka. The data are collected on a diachronic basis to gain information on the extent of poverty and marginalization across motorized sectors.
- The FGT (Foster, Greer and Thorbecks) index was worked in the case of the motorized sector in the four states. The total people below poverty line were estimated based on the sample percentage of the poor and using the Marine Fisheries Census data (2005). It was found that the state average figures for BPL families were much above the sample estimates.

Poverty head count using the PPAR in the motorized sector

	Sample		N state		Estimated	
state	sample n	poor%	n poor	poor	poor	State %
KLA	928	6.1	57	1428	215	15
KKA	911	12.51	114	1894	458	24.1
TN	934	10.1	94	5452	1438	26.4
AP	929	9.8	91	3852	788	20.45

- The findings indicate that poverty estimates, as in the case of traditional sector which was reported last year, should be considered more under the rubric of relative poverty. It should also taken into account factors like inter-sectoral and intra sectoral incongruence in terms of asset entitlements, livelihood deprivation, health and access to the fish resources as well as means of production.
- As per the health parameters gathered through the data collection, the motorized sector was found to be getting increasingly afflicted by lifestyle diseases like high blood pressure, coronary problems, high blood sugar *etc*. A typical motorized fisherman's family spends about 67.2 to 77.9% of his income on nonfood items. The indebtedness ranges from Rs.33, 454 - Rs.76,401 (across the states average). PDS

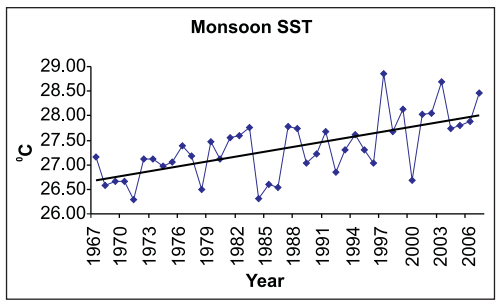
dependence was found to be less compared to the traditional sector with many respondents expressing unsatisfactory performance of PDS. The Tamil Nadu fisher folk registered maximum satisfaction (79.86%) on this count. The extent of school drop-outs was found to be maximum in Andhra Pradesh (19.34%) followed by Karnataka (18.8%) Tamil Nadu (16.7%) and Kerala (4.2%). Adoption of birth control measures was found to be high in Kerala (88.3%) followed by Tamil Nadu (79.2%), Karnataka (72.1%) and Andhra Pradesh (69.12%).

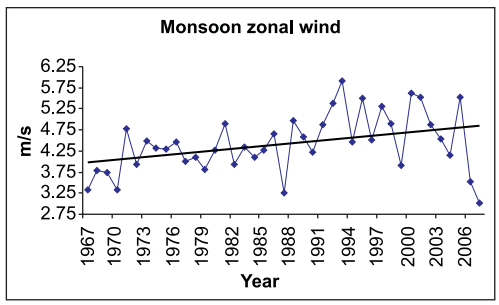
PROJECT CODE	**SEE/PET/01**
PROJECT TITLE	**Impact of WTO regulations on Indian fisheries trade: A policy perspective**
SCIENTISTS	**Shyam S. Salim,** R. Sathiadahs, N. Aswathy, Vipin Kumar and T.M. Najmudeen
CENTRE	Kochi

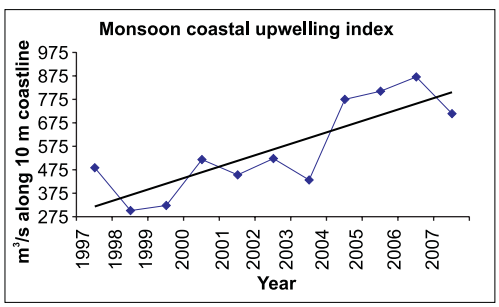
- Export of marine products from India was valued at a record $1.91 billion during 2008-09. Compared to the year 2007-08 the marine products exports registered an increase of 11.29% in terms of quantity, 12.95% increase in value and marginal 0.5% increase in the dollar realization. The sector is expected to grow at 10-15% during 2009-10 and cross 2.2 billion dollars during 2009-10.
- Frozen shrimp continued to be the single largest item of export in terms of value accounting for about 44% in the total export earnings. In terms of quantity, fin fish accounted for the major share at 40%.
- The contribution of the cultured shrimp exports to the Indian shrimp export basket declined 55 to 45%. The farmed shrimp production in the country has declined on account of reduction in the farmed area coupled with disease outbreak and decreasing productivity.
- Anti-dumping duty had a major impact on shrimp exports to the US which plummeted from $409 million in 2003 before the duty imposition to $142 million in 2008. The exports to US have considerably increased after the reduction in the antidumping duty from 14.4 to 0.79% during 2008-09.
- The average capacity of the processing plant was found to be 32.12 t. The average capacity utilization of the processing plant was found to be 12.10 t which constitute only 37.7% of the capacity utilization.
- The average number of processing days per plant was found to be 230 days per annum. The quarter-wise details on the number of days processing plants were in operation indicated that during the period from October to December months contributed to 30.39% followed by January- March at 28.29%.
- The average quantum of marine fish products processed per processing plant was found to be 2781.70 t per annum. The quarter wise details on the quantity processed indicated that the October to December months contributed 39.45% followed by January- March at 28.46%.
- There exists an emerging market of Puffer fish lagocephalus which is presently exported to Japan, China and South-east Asian countries which is sold at Rs. 40-50 per kg in the export market.

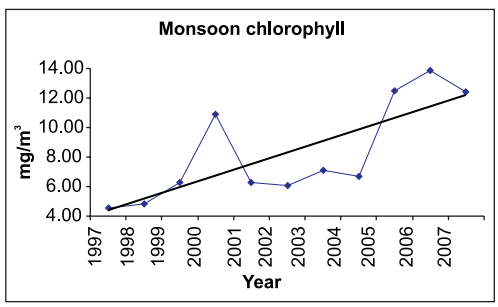
SPONSORED PROJECTS
Marine Resource Assessment

FUNDING AGENCY	**Indian Council of Agricultural Research (ICAR)**
PROJECT TITLE	**Impact, adaptation and vulnerability of Indian marine fisheries to climate change**
SCIENTISTS	**E. Vivekanandan,** N.G.K. Pillai, K.S. Mohamed, J. Jayasankar, V.V. Singh, Joe Kizhakudan and R. Jeyabaskaran
CENTRES	Kochi, Mumbai and Chennai









Variation in climatic and ocanographic features in the Arabian sea off Kerala during 1997-2007

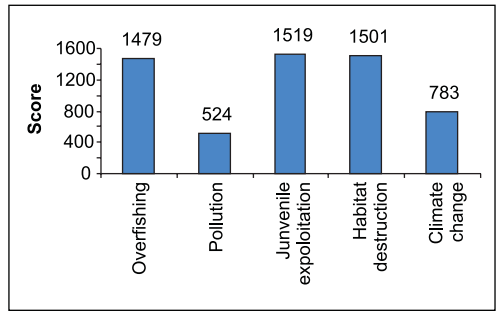
Seasonal and inter-annual changes in oceanographic features and their impact on small pelagic catches off Kerala

- The catch of small pelagics, especially that of the oil sardine has increased from 1,554 t in 1994 to 2,50,469 t in 2007 in the upwelling zone off Kerala (south-west coast of India). Time series data of different climatic and oceanographic parameters gathered from different sources showed that, during 1967-2007, the annual sea surface temperature (SST) increased by 0.15 °C per decade; scalar and zonal wind speeds also increased during these four decades. The SST is showing increasing trend and the surface winds are also strengthening. The coastal upwelling index (CUI) during south-west monsoon increased by nearly 50% from 1997 to 2007. This substantial increase in CUI elevated the chlorophyll *a* concentration during monsoon. The high concentration and increasing trend of Chl *a* during the monsoon resulted in increase of over 200% in annual average Chl *a* concentration. The increasing CUI and Chl *a* during monsoon sustained an increasing catch of oil sardine during post-monsoon season. This trend indicates that the current warming is beneficial to herbivorous small pelagics. The responses of lesser sardine and Indian mackerel, which are midlevel carnivores, were different. The population increases of the oil sardine appear to replace decreases in the lesser sardines and Indian mackerel during the post-monsoon season.

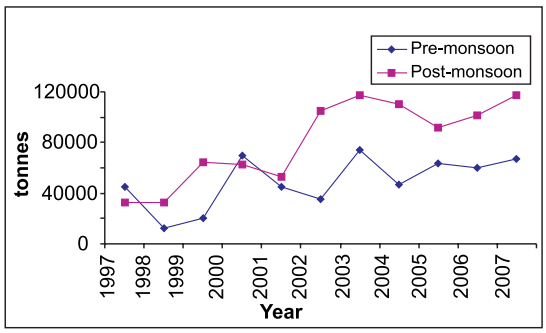
Indigenous Technical Knowledge (ITK) of fishermen on climate change

- Interview with 591 fishermen from the states of Maharashtra, Kerala and Tamil Nadu, has provided information on weather-related ITK of coastal fishermen and how best the ITK could be integrated for advancement of scientific research to evolve options to adapt to climate change. The following conclusions could be drawn from the interviews:
- Marine fishermen have heard about climate change, but are confused with annual climatic variability and climate change.
- The perceptions on climate change and adaptation options differ between fishermen of different states.
- They believe that reduction in fish catch in recent years is essentially due to juvenile exploitation, habitat destruction and overfishing.
- Fishermen attach maximum importance to wind direction and speed as the drivers of fish abundance and availability, followed by rainfall and temperature. They believe that direction as well as speed of wind and temperature have changed over the last 20 years, which will have adverse impact on fisheries.

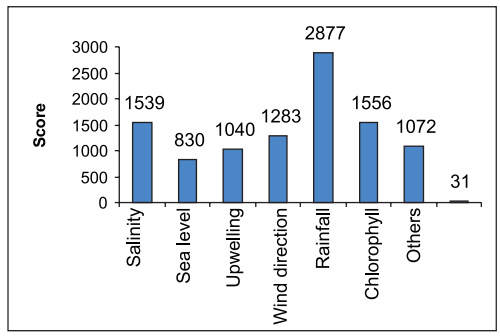
- Sea erosion in Kerala and Tamil Nadu, cyclones in Maharashtra and Tamil Nadu and sea status off Maharashtra are perceived as major safety concerns.
- In the event of cyclones and sea erosion, fishermen of Tamil Nadu prefer temporary exit from their villages; their counterparts in Kerala prefer temporary exit as well as permanent rehabilitations to interior dwellings.
- A large majority of fishermen listen to and follow daily weather bulletins in the media. They are prepared to take weather related insurance if the premium is within their capacity.
- Fishermen believe that fish catches will decline in future. However, they do not want to leave the profession, but want their children employed in government jobs.



Issues in marine fisheries (the values are pooled scores for three states based on fishermen response)



Oil sardine landings of Kerala during 1997-2007



Importance of climatic and oceanographic parameters to fisheries (the values are pooled scores for three states based on fishermen response)

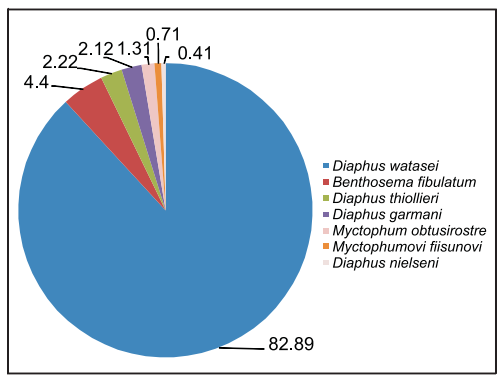
FUNDING AGENCY **Ministry of Earth Sciences (MoES)**

PROJECT TITLE **Assessment of myctophid resources in the Arabian Sea and development of harvest and post harvest technologies**

SCIENTISTS **N.G.K. Pillai,** E. Vivekanandan, E.M. Abdussamad, U. Ganga, Prathiba Rohit, K.P. Said Koya, P.P. Manoj Kumar and Subhadeep Ghosh

CENTRES Kochi, Visakhapatnam, Calicut and Veraval

- Myctophids were collected as bycatch from commercial deepsea shrimp trawlers operated from Cochin, Shaktikulangara and Tuticorin harbours. Since this group is having no economic value, most of these catches were discarded in the sea at the time of catch itself. Some of the samples were collected from the bycatch for taxonomic and biological studies. Based on the studies so far carried out, the following observations were made. Among the myctophids, *Diaphus watasei* from family Myctophidae and *Neoscopelus microchir* from family Neoscopilidae were the dominant representatives. Other important representatives of mesopelagics belonged to the families Phosichthyidae, Sternoptychidae, Gonostomatidae, Stomidae, Gempylidae, Gadidae and Ophididae. Night hauls were dominated by myctophids and other non-commercial deepsea fishes rather than shrimps; this is due to the vertical migration of most of the mesopelagic fishes. The identified species were *Diaphus watasei, D. garmani, D. thiollieri, D. nielseni, Myctophum obtusirostre, M. fissunovi* and *Benthosema fibulatum*



Percentage composition of myctophids landed by deepsea shrimp trawlers from south-west coast of India

Diaphus garmani

- The myctophid *D. garmani* is recorded for the first time from Indian waters based on 3 specimens (54-59 mm standard length) collected from deepsea shrimp trawlers off Quilon, south-west coast of India, between 8^0 - 11^0 N and 74^0 - 76^0 E, at depths from 250 to 450 m. Identification was as per Nafpaktitis (1978) and relied on the luminous organs on the head, number of fin rays, gill rakers and morphometric characters. The specimens of *D. garmani* were deposited in the National Biodiversity Referral Museum, CMFRI, India under the accession Number GB.27.1.5.25.
- *Diaphus watasei* was often abundant in bottom trawl catches. This species ranged in length between 6.2 to 11.5 cm in males with a mean length of 8.8 cm and 7 to 13 cm in females with a mean of 10 cm. In all the catches females were dominant. Sex ratio of *D. watasei* was 1:2.13 male:female. Species tend to spawn year-round and matured species are available throughout the year. Among the gut contents, euphausids appeared to be the most important food item, followed by copepods, prawns and small squids.
- Species specific partial sequence profile of *D. watasei* and *B. fibulatum* covering 16S rRNA and COI were generated. Amplified sequence showed 100% matching with available sequence from the NCBI site.

Deepsea trawl catch

- Participated in a deepsea fishery trawl survey of RV *Matsyavarshini* conducted by Fishery Survey of India during February, 2010 to assess the deepsea fishery resources mainly of myctophids in the south-west coast of India. Seven stations representing various depths were covered between the Lat. 09^0 09' N; and Long. 76^0 52' E and Lat. 10^0 45' N; Long. 75^0 16' E. They operated bottom trawls at depth ranges from 30 m to 510 m. Depth-wise distribution of deepsea fishes was studied. The major components of the trawl catch were species belonging to the families Myctophidae, Sternoptychidae, Gonostomatidae, Ateleopodidae, Chlorophthalmidae, Ipnopidae, Evermannellidae, Neoscopelidae and Stomiidae. *Neopinnula orientalis* dominated the catch at the depth range of 280 - 340 m and myctophid *D. watasei* dominated the catch at the depth of 380 – 510 m. Deepsea prawns like *Aristeus alcockii, Heterocarpus woodmasoni, H. gibbosus, Plesionika spinipes* and *Metapenaeopsis andamanensis* were observed in the catch. Subsamples of all catches were collected and preserved in formalin for further analysis.

FUNDING AGENCY	**Indian National Centre for Ocean Information Service (INCOIS)**
PROJECT TITLE	**Validation of PFZ advisories brought out by INCOIS among artisanal and small mechanized sector fishermen along Kerala coast to compare the advantages derived for different types of fishing operations / targeted species**
SCIENTIST	**Dr. V. Narayana Pillai**
CENTRE	Kochi

- During the period under report, out of a total of 43 PFZ advisories released for the Kerala coast, 29 were validated. 14 advisories could not be validated because of their location in the offshore waters far way from the coast. On an average 18 to 28 numbers of fish landing centres were visited every month to gather data on validation of PFZ advisories and also regular collection of marine fish landings. Data

has been gathered from a total of 98 to 126 vessels each month. A total of 21 experiments were conducted by engaging more or less identical fishing vessels fitted with GPS, employing fishing gear of more or less same dimension simultaneously within and outside notified area to arrive at the economics of operation and advantages derived through the usage of PFZ. Related hydrographic data (seawater temperature, salinity, dissolved oxygen levels, nutrients, phytoplankton, zooplankton at surface and subsurface levels) were also gathered from 8 locations within and outside notified area engaging a large purse seiner to attempt possible correlations with availability/abundance of major pelagics.

Ring seine being hauled

- The study revealed that Potential Fishing Zone advisories, the only short-term forecast for marine fisheries available in the country which are brought out on the basis of satellite Sea Surface Temperature (SST) and chlorophyll imageries is found useful for locating pelagic fish concentrations. The major beneficiaries are the artisanal and small mechanized/motorized sector fishermen. Timely forecasts of PFZ based on SST and/or surface chlorophyll concentrations can help in minimizing the searching time for shoaling fishes which in turn can result in the saving of valuable human effort and also fuel for the mechanized/motorized vessels there by bringing down the overall cost of fishing operations.

Transferring ring seine catch to a carrier boat

- Fishing operations undertaken on or closer to dates on which related SST/chlorophyll images have been received yielded positive results. When the gap increases the yield within PFZ is likely to come down unless the features remain more or less in the same location as revealed by the succeeding satellite imagery. The fish catch within PFZ area gave higher CPUE and net profit compared to the catches from operations outside PFZ areas. Average income derived by vessels which operated in the PFZ areas were considerably higher than vessels which operated outside PFZ areas. Fishing expenses were also comparatively less for vessels which operated within PFZ through reduction in searching time which in turn resulted in saving of valuable fuel and also human effort.
- Approximately 71% of the total marine fish catch along Kerala coast was from pelagic species. Oil sardine, mackerel, anchovies, tunas, seer fishes and carangids constituted about 65% of the pelagic stock that formed about 35% of the total marine fish catch of the country as a whole. The usefulness of PFZ advisories for the marine fishermen engaged in different types of pelagic fishing activities does not need any further emphasis.

Oil sardine landed by ring seine units

FUNDING AGENCY **Ministry of Earth Sciences (MoES)**

PROJECT TITLE **Studies on marine mammals of Indian EEZ and the contiguous seas**

SCIENTISTS **E. Vivekanandan,** P.P. Manojkumar, K.P. Said Koya and R. Jeyabaskaran

CENTRES Kochi and Calicut

- During May and June 2009, eight boat based short surveys were undertaken in Cochin backwaters to estimate population size and behavioural patterns of Indo-Pacific humpbacked dolphin, *Sousa chinensis* using photo identification method. The survey indicated occurrence of two groups, each comprising of 2 to10 individuals of

Indo-Pacific humpbacked dolphin *Sousa chinensis*

adult and sub-adults. The behavioural study showed that the Indo-Pacific dolphin regularly uses Cochin backwaters, especially the bar-mouth of Vypeen and Fort Cochin where Chinese nets are operated, for feeding during high tide. For Dolphin Watch, the high tide period in Cochin backwaters appears to be ideal location. Cochin backwaters is frequented by a large number of vessels ranging from larger ships to small fishing boats. Most of the individuals demonstrated quick response to vessel movement by moving out of the vessel course to avoid getting collided. Similarly, heavy vessel traffic does not seem to affect the feeding behaviour of the dolphins.

Survey onboard FORV *Sagar Sampada*

- Between April and December 2009, five oceanic visual surveys were carried out onboard FORV Sagar Sampada to assess marine mammal diversity and their distribution in oceanic waters of Indian Seas and Indian Ocean. The survey areas were western and eastern parts of the Indian seas and southern part of Sri Lankan waters (Indian Ocean). A total of 505 hours of survey effort was made in 71 days to cover 3900 nautical miles. A total of 27 sightings of two species of baleen whales and five species of delphinids were recorded, which comprised of about 1074 individuals.

The spinner dolphin *Stenella longirostris*

- *Stenella longirostris* (spinner dolphin) was the most frequently sighted species showing a wide distribution. *Delphinus capensis* (long-beaked common dolphin), *Sousa chinensis* (Indo-Pacific humpback dolphin), *Stenella attenuata* (pan-tropical spotted dolphin) and *Tursiops aduncus* (Indian Ocean bottlenose dolphin) were the other delphinids sighted frequently during this period. *Balaenoptera musculus* (blue whale) and *Balaenoptera edeni* (Bryde's whale) were recorded on a few occasions. High frequency of occurrence of baleen whale (*Balaenoptera* sp.) was observed in the southern Sri Lankan waters.

Indigenous Technical Knowledge (ITK) of fishermen on marine mammals

- Fishermen interviews were conducted to collect information on ITK on marine mammals. A total of 370 fishermen comprising 200 fishermen from nine districts of Maharashtra and 170 fishermen from three districts of Kerala were interviewed. In Kerala, 98% of fishermen conveyed that marine mammal occurrence is related to the abundance of pelagic fishes such as sardines, mackerel, tuna and seer fish. Majority of fishermen (>98%) in Kerala are of the opinion that marine mammal populations have increased in recent years, whereas in Maharashtra only 52% of fishermen agreed on this. In Kerala, about 90% of fishermen who use monofilament gillnet for sardine fishing complained of heavy economic loss due to net damage by dolphin forage behaviour. About 83.3% of fishermen in the two states agreed that there are incidental catches of dolphins in their fishing nets. However, they denied intentional killing or targeting marine mammals. Most of the fishermen were aware of Wildlife (Protection) Act. In Maharashtra, about 99% of the fishermen responded in favor of the Wildlife act because of their sentimental approach to marine mammals. However, 77.5% of fishermen in Kerala urged removal of Wildlife act and wanted legal consent to kill dolphins whenever fishing is disturbed by dolphins.

Indian Ocean bottlenose dolphin *Tursiops aduncus*

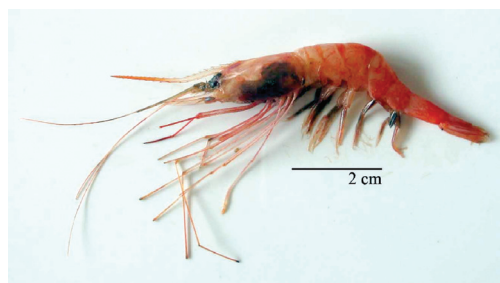
FUNDING AGENCY	**Tamil Nadu Fisheries Department**
PROJECT TITLE	**Establishment of four artificial reefs by fishermen on participatory mode along Tamil Nadu coast for marine fishery resource enhancement**
SCIENTIST	**G. Mohanraj**
CENTRE	Chennai

- Fabrication and installation of artificial reefs at Light house Kuppam (Tiruvallur), Mallipattinam (Thanjavur) and Chinna Neelankarai (Kancheepuram) have been completed with the involvement of the NGO, Participatory Learning Action Network and Training (PLANT). Deployment of artificial reef structures is under progress at Light house Kuppm, Mallipattinam and Chinna Neelankarai.
- The fabrication and deployment of artificial reefs at Arockiapuam (Kanyakumari) would be completed by the end of June 2010.

FUNDING AGENCY	**Ministry of Earth Sciences (MoES)**
PROJECT TITLE	**Assessment of fishery resources in the continental slope of Indian EEZ and Central Indian Ocean.**
SCIENTIST	**U. Ganga**
CENTRE	Kochi

- The targeted fishery for deepsea sharks by select drift gillnet cum hooks and line units operating at depths beyond 400 m operated from the Cochin Fisheries Harbour base was monitored. The targeted deepsea shark fishery at Cochin stopped in the early 2009 due to falling catch rate and price fall, possibly due to economic recession and decrease in exports. But deepsea chondrichthyans continued to occur in the deepsea shrimp trawls, gillnet and hooks and line units in bulk quantity. Interviews with shark fishermen revealed a possible migration of the deepsea shark fishing units to Andaman waters where large-sized *Centrophorus* spp. is available in good quantity.
- Of the more than 36 species of deepsea sharks recorded, *Echinorhinus brucus* which landed regularly was studied in detail. Nearly 69% (in numbers) of *E. brucus* landed were immature. Large numbers of gravid females were observed during February-April and October-December period. Females dominated in landings throughout the study period
- *Zameus squamulosus* (Somniosidae), pygmy false catshark (undescribed) (Pseudotriakidae) and *Etmopterus pusillus* (Etmopteridae) were observed in the chondrichthyan landings at Cochin, of which, the first two were new distributional records from Indian waters.
- Deepsea skate, *Rhinobatos variegatus* Nair and Lal Mohan, 1971 was observed occasionally in large numbers as trawl bycatch. Their depth of collection was shallow (<200 m) compared to that reported (360-450 m) for the holotype.
- In the deepsea shrimp fishery, dominant species were *Plesionika spinipes*, *Heterocarpus woodmasoni*, *H. gibbosus*, *Metapenaeopsis andamanensis*, *Aristeus alcocki* and *Solenocera hextii*.
- Deepsea shrimp, *Plesionika adensameri* (Balss, 1914) was collected from the deepsea shrimp trawl landings at Tuticorin Fisheries Harbour and Kalammukku landing centre which was a new distributional record from the Indian waters.

Eggs of the deepsea shark, *Echinorhinus brucus*

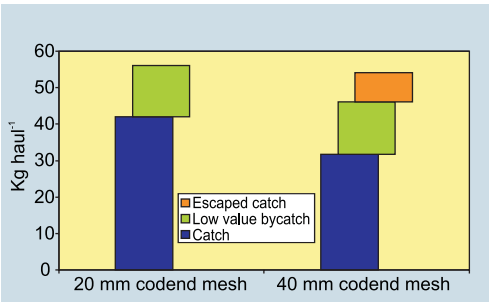


Deepsea shrimp, *Plesionika adensameri*

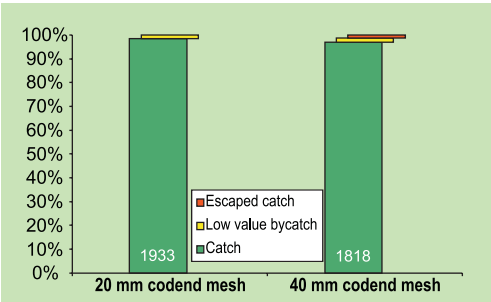
FUNDING AGENCY	**Marine Products Export Development Authority (MPEDA)**
PROJECT TITLE	**Participatory management and conservation of lobster resources along the Indian coast**
SCIENTISTS	**E.V. Radhakrishnan (CMFRI),** B. Meenakumari and Pravin Puthran (CIFT)
CENTRE	Kochi

- Two thousand posters and conservation leaflets were distributed in 20 lobster fishing villages in Tamil Nadu. The completion report has been finalized.

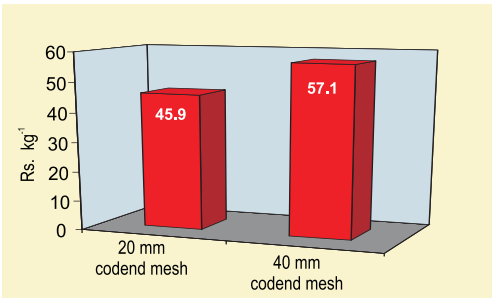
FUNDING AGENCY	**Marine Products Export Development Authority (MPEDA)**
PROJECT TITLE	**Demonstration of responsible fishing practices for the trawl fisheries of Gujarat State**
SCIENTISTS	**K.S. Mohamed,** P.K. Asokan, S. Ghosh and E. Vivekanandan (CMFRI); B. Meenakumari, P. Pravin and V.R. Madhu (CIFT)
CENTRES	Kochi and Veraval



Change in average CPUE due to use of 40 mm cod-end mesh. Note that there is no difference in the proportion of LVB in both meshes



Change in average price realized per haul as percentage of total due to use of 40 mm cod-end mesh.



Difference in unit value of fish caught due to use of 40 mm cod-end mesh

- The project was proposed by CMFRI to tackle the problem of excessive young and juvenile fish and shellfish caught in trawls operated with small mesh sizes throughout the country. The MPEDA organized several meetings with the seafood industry and fisher groups to find a solution to this problem. The majority opinion was that trawl owners are not convinced that there would be profitability in trawl operations if government notified mesh sizes were used. Hence MPEDA agreed to fund a project to demonstrate the use of MFRA notified mesh sizes for trawl boats of Gujarat in tune with the FAO code of conduct for responsible fisheries. The industry offered the use of 3 trawl boats in Gujarat for use in the project. The project was jointly executed by CMFRI and CIFT and the final report was submitted in December 2009.
- Results of the study indicate that the average amount of fish which escapes because of using 40 mm codend mesh instead of the usual is 8.1 kg haul^{-1}. This amounts to roughly 20% of the catch. The average loss per haul in monetary terms is Rs. 23/- which is about 1.3% of the total revenue realized per haul. The average CPUE between trawls using 20 and 40 mm CEM were not significantly different ($p>0.05$). When using 40 mm codend mesh there will be an increase in unit value of the fish caught by 24%. This happens because of the absence of small fishes in the catch, raising the unit value of the catch. Clear rightward shifts in modal lengths were seen in most species when the number of animals per haul was compared on the basis of length between 20 and 40 mm CEM trawls.
- The main expense in operational costs was due to diesel (85%) and the remaining was on ice, others and oil. On an average, the monthly profit was about Rs. 76,000/-. Since the loss in terms of value of escaped catch was determined as 1.3% on account of using 40 mm square codend mesh, it is not expected to make any significant impact on vessel economics and overall profitability of operations.
- On the other hand, the use of legal mesh size would pave the way for certification of the fisheries as sustainable, a requirement which is being increasingly demanded by importers.
- These results need to be brought to the notice of the fishers, boat owners, seafood industry, NGOs and concerned government

departments at the centre and state. It is recommended that MPEDA through its official machinery give wide publicity by holding seminars, movie screening and discussion forums in all maritime states.

- A 16 minute video entitled 'Trawling for future - a guide to responsible fishing' was produced in 4 languages (English, Gujarati, Hindi and Malayalam). The English version in low resolution format has been uploaded into the YOUTUBE website for wider viewing (http://www.youtube.com/watch?v=AUaixPHjpSk).

Video film on 'Trawling for future - a guide to responsible fishing'

Mariculture

FUNDING AGENCY	**Ministry of Agriculture (MoA), Govt. of India**
PROJECT TITLE	**Open sea floating cage demonstration farm for R&D in marine finfish and shellfish production**
SCIENTISTS	**G. Syda Rao,** G. Gopakumar, Imelda Joseph, Rani Mary George, A.P. Lipton, G. Maheswarudu, K.K. Philipose, M.K. Anil, A.K. Abdul Nazar and Ritesh Ranjan
CENTRES	Mandapam, Karwar, Visakhapatnam and Vizhinjam

Seabass grading with automatic grader

Cage site at Visakhapatnam

Releasing of seabass seed into hapas at Visakhapatnam

Culture of Seabass *Lates calcarifer* in open sea floating cages

- At Karwar, new site for cage culture was identified. Three metal rafts (6 x 6 x 6 m) were fabricated and launched. Ten thousand sea bass seeds were brought from RGCA, Sirkali (2.8 g, 6.2 cm) and nursery rearing was done in cement tanks (3000 seeds in 7 tonne tank). Feeding done with artificial diet three times daily @5% body weight. Grading and sorting done every 10 days with automatic grader. 100% survival achieved in nursery. After 45 days they were shifted to floating cages at Karwar. In cages, fishes were fed with chopped oil sardines four times daily at 30% body weight. First batch reached an average weight of 100 g in 22 days.

- At Visakhapatnam, the cage is located in the Bay of Bengal off Visakhapatnam at 17^0 42' 64'' N; 83^0 29' 639'' E. The ranges of water parameters recorded at the cage site: salinity: 25-33 ppt; temperature: 26-28 ^{0}C; pH: 8.0-8.4; bottom profile: rocky and sandy; depth: 9-10 m. About 10,000 seabass seed (5-6 cm) brought from RGCA, Srikali were stocked in open sea floating cage (15 m dia) installed off Visakhapatnam in March, 2010. Seabass fingerlings were stocked in two hapas that were fixed in the cage. Feeding is being carried out with *Artemia* nauplii, shrimp feed and *Artemia* flakes twice a day.

- At Mandapam, seabass *Lates calcarifer* seed (45 to 50 mm) brought from RGCA were initially reared in cement and FRP tanks. A total of 2900 seabass seeds (76 - 138 mm) were transferred to a sea cage of 6 m diameter in January 2010. Another cage was stocked with 2437 numbers of seabass seeds in February 2010. Feeding is being carried out with fresh sardine @5% of the biomass.

- At Vizhinjam, 6,600 numbers of hatchery produced Asian seabass *Lates calcarifer* seed from MPEDA managed RGCA hatchery at Mayiladuthurai, Tamilnadu were procured and air lifted from Chennai to the centre. Due to differential growth, the fish (4.0-5.0 cm) were reared in hapa in the sea for periodic grading. On reaching above 50 g size, the fish were released to the grow-out net in the cage in February 2009. On 12th July 2009, a total of 554 kg (1027 numbers) of seabass was harvested from inner and outer nets of the cage. The average size at the time of harvest was 539.53 g (weight) and 327.36 mm (total length).

Stocking of seabass seed in hapa in pond

Aeration in seabass nursery rearing pond

Seabass fingerlings for stocking in the cage

Seabass seed ready to be transferred to cage

Catching fishes from cage

Harvested seabass

Kanyakumari

- Seabass young ones were transported to the cage site, conditioned and maintained in hapas and released in the cage. The size ranged from 140 to 165 mm length.
- A Tamil pamphlet (*Kadalil mithavai koondugal moolam meenv valarpu*) was prepared for circulation among those interested in cage farming (CMFRI pamphlet No: 11/2009). The pamphlet was released during the lobster harvest function

Release of Tamil pamphlet

Culture of tiger shrimp *Penaeus monodon* in open sea floating cage

- At Visakhapatnam, about 1.5 lakh PL23 of *Penaeus monodon*, were stocked in to the 6 m dia cage with net of 2 mm mesh velon screen. Shrimp feed of C. P. Aquaculture Private Ltd was used. During first 17 days, feed was given twice a day, in the morning (08.00 hrs) and evening (16.00 hrs). From day 18th onwards feed was given thrice in a day, morning (08.00 hrs), afternoon (13.00 hrs) and evening (17.00 hrs). *P. monodon* registered a growth rate of 0.86 mm (TL) / day during first 30 days; 0.89 mm/ day during 31-60 days; and 0.86 mm /day during 61-90 days. Culture was closed after 99 days as the shrimp stock was infected with White Spot Syndrome virus. The total shrimp harvest was about 190 kg and the computed FCR was 4.26. The survival at the time of harvest was 31%.

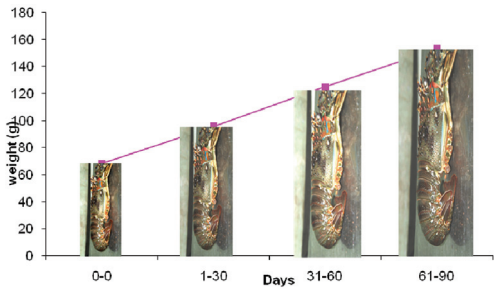
Farming of spiny lobster in sea cages

- At Vizhinjam, spiny lobster *Panulirus homarus* of size 80-184 mm (TL) with a mean body weight of 93 g were procured from Vizhinjam, Chinnamuttom, Kadiyapatnam and Kollam during September-November. One thousand two hundred numbers of *P. homarus* (90- 200 g size) were stocked in the cage in January 2009. A function for harvest of lobsters was organized on 2nd June 2009.

Harvested *Penaeus monodon* on day 99 at Visakhapatnam

Cage installed off Kanyakumari

Lobsters ready for stocking in cage



Growth of lobsters reared in cage

Harvest of lobsters at Vizhinjam

Dignitaries with the harvested lobsters

A total of 825 numbers of (187 kg) of lobsters were harvested and the survival recorded was 75%. The average weight of harvested lobsters was 225.95 g and average length was 169.82 mm. Total revenue of Rs.1.5 lakh was realized by the sale of lobsters.

- At Kanyakumari, spiny lobster *Panulirus homarus* (2400 numbers) with an average length of 110 mm and average weight of 68.5 g were stocked. A total of 175 kg of lobsters were harvested after 94 days of rearing in the cage in sea. The weight ranged from 110 to 245 g and the length from 160 to 210 mm. A gross revenue of Rs. 2,10,000/- with a net income of Rs. 38,725/- was obtained. The capital productivity ratio was 0.4. The economic details are given in the Table. The cage was restocked with the lobster young ones for the subsequent crop.

Economic features of lobster mariculture in open sea floating cages

Stocking details	
Total no. stocked in cage	2400
ABW at the stocking time	68.5 g
ABL at the stocking time	110 mm
Seed source	Natural collection
Harvest details (Partial harvest)	
Period of culture: 94 days	
Total harvested weight of lobsters	175 kg
Maximum weight	235 g
Minimum weight	110 g
Maximum length	210 mm
Minimum length	160 mm
Economic indicators	
Particulars	**Amount in Rs.**
Investments for 6 m diameter cage	4,00,000/-
Total cost of production	1,20,275/-
Gross revenue	2,10,000/-
Net income	89,725/-
Cost of production	687/-
Price per kg of lobsters	1200/-
Capital productivity (Ratio)	0.41

- At Mandapam, the cage was launched at the southern side of the Regional Centre of CMFRI, in the Gulf of Mannar in October 2009 and was stocked with 1300 numbers of spiny lobster juveniles (*Panulirus homarus* and *P. ornatus*) collected from Tuticorin and Kanyakumari areas, weighing 65 to 85 g. The lobsters were fed *ad libitum* thrice a day with chopped trash fish and *Octopus* sp. After three months of stocking, a partial harvest of the stock was arranged near the seashore gate of the Regional Centre on 5th February 2010. The lobster cage was brought near the shore and those weighing above 200 g were harvested. A total of 127.1 kg of lobsters were harvested and Rs.1,27,100 /- @ Rs. 1000 per kg was realized and the same was handed over to Shri. E. Altrin, the representative of the collaborating SHG, the Fishermen and Handicapped Education Economic Development Trust (FEED Trust) in the function.

FUNDING AGENCY	**National Fisheries Development Board (NFDB)**
PROJECT TITLE	**Open sea cage-culture demonstration farms in India**
SCIENTISTS	**G. Syda Rao,** V.D. Deshmukh, Imelda Joseph, Shoji Joseph, Boby Ignatius, Gulshad Mohammed, A.P. Dinesh Babu, Sujitha Thomas, Geetha Sasikumar, G. Maheswarudu, Rithesh Ranjan, M.K. Anil, B. Santhosh, Joe K. Kizhakoodan.
CENTRES	Kochi, Mangalore, Karwar, Chennai, Kakinada, Balasore, Veraval and Mumbai

Balasore

- At Balasore, the cage was launched in January, 2009 and stocked with 4357 nos. of Asian seabass of average size 55-85 g. The harvest was done in November 2009, and 3472 nos. of fishes were retrieved with an average weight of 872 g each (max 1.3 kg and min 560 g) and survival was 79.6% with a total production of 3031 kg. The rearing of the fishes and safety of the cage was achieved with the help of State Government. The ongoing culture is entrusted with a fishermen cooperative and 5000 nos. of seeds weighing 20-25 g mean size were handed over to them along with the cage and nets.

Harvest at Balasore

Veraval

- In January 2009, a 6m diameter cage was launched at Sutrapada Village in Veraval. In this area, the juveniles of spiny lobsters are exploited indiscriminately by trawlers and as a conservation measure, spiny lobster *Palunirus polyphagus* was selected for cage culture. About 2048 juveniles of average 40 g size were stocked in the cage @ 30 numbers/m^2, with daily feeding using fish/ molluscan meat @ 10% of biomass. After 120 days of culture, the lobsters were harvested in May 2009. The lobsters attained a weight of 235 g on an average and the survival was 97%. The feed conversion ratio was worked out to be 6.164.

Cage at Veraval

- During the current season, polyculture of shellfish and finfish is being done in the cage. Along with, 1736 juveniles of *P. polyphagus*, weighing an average 44.4 g, caught by trawlers were collected and stocked in the cage @ 26 numbers /m^2. About 2450 *Mugil cephalus* juveniles weighing on an average 23.36 g, caught by cast nets were stocked in the cage @ 4 numbers /m^3. Lobsters were fed daily with fish/ molluscan meat and mullets with rice bran and soybean mixture @ 10% of biomass, distributed evenly in the morning and evening hours. The culture is in progress.

Harvested *P. polyphagus*

Kochi

- Seabass seed brought on 17th November 2008 (3-4 cm) from RGCA were nursery reared in hapas at KVK Narakkal for one month. Nursery reared seeds were then transferred to the cages moored in open sea. Trash fish and small shrimps were fed *ad libitum* to the fishes in the cage twice daily. In an emergency situation after a period of 4 months, the fishes were harvested on 18 March 2009. A total of 1015 fishes were harvested and the total production was 500 kg. The average weight of harvested fish was 285 g. The maximum size reached was 695 g and the minimum 135 g. The growth rate was encouraging but the survival was only satisfactory for the given size of seed.
- In the second season, *Mugil cephalus* seeds collected from the wild (2 – 4 cm) were purchased and nursery reared for a period of 2 months

Harvest of seabass at Kochi

Harvested seabass

Nursery rearing of seabass at Kochi

Cages at Byndoor, Mangalore

Cage launching at Mumbai

in the nursery ponds till it reached 10 to 15 cm. The fish were fed thrice daily with artificial feed and wheat bran. Hapa were cleaned on alternate days. The fingerlings (12–15 cm) were stocked in the cage in open back water. The culture is in progress.

- Seabass fry (4-5 cm and 1.5-4 g) were brought from the RGCA hatchery and stocked in the hapa and the nursery rearing was done in a tide fed pond for a period of two months. The fishes were fed with small prawns and commercial shrimp feed (Godrej) @ 12% body weight thrice daily. The fish were graded once in a week according to the size ranges to cope with differential growth and associated cannibalism. On reaching 10-12 cm and 90-100 g, the fish were transferred to the cage in open water and feeding with trash fish is done. The culture is in progress.

Mangalore

- In association with Traditional Fishermen Society, Byndoor, two cages were moored at Mangalore in an offshore site 3 km away from the coast at a depth of 10m, near Byndoor (Upunda). The cages were stocked with *P. indicus* (1, 50,000 nos., 35 mm TL) and *P. monodon* (2, 00,000 nos., 12 mm TL). Unprecedented rough weather in the sea on the second week of April 2009 lead to the emergency harvest of the shrimps. The average weight of *P. indicus* harvested was 10 g and that of *P. monodon* was 6 g.
- Seabass fry (4.5-5.5 cm) procured from RGCA, during September, 2009 were transported to Deejay hatchery, Uttara Kannada, Karnataka. In the hatchery fry were reared in cement tanks of 15 t capacity @500 nos / m^3 by feeding imported compounded feed @8% body weight. Flow-through system was maintained at a flow rate of 500 l/h. Grading was done at two weeks interval. The seabass seed reached 110 mm in 50 days with weight ranging from 20 to 25 g, with survival rate of 94.2% in the hatchery.
- Two circular cages of 6 m diameter were installed at Uppunda during the last week of December, 2009 and January 2010 at 6 m depth, 2 km from the shore. Seabass of 160-205 mm length and 80-100 g weight were stocked in the cages at a stocking density of 3,500 nos/ cage with 3.5 mm net webbing in two batches. Feeding was done *ad libitum* with a mix comprising trash fish, bivalve meat and juvenile shrimps along with compounded feed.

Mumbai

- Two 6 m diameter cages have been moored in the sea off the village Kalamb at Mumbai for lobster and fish stocking. The cages were moored with about 2.5-3 t weight and secured to the 200 l capacity HDPE buoys by 12 mm iron rope and 16 mm PP ropes through iron swivels. The two cages are moored 500 m apart, safe from severe wave action and drifting. With the help of fishermen groups, the fishes stocked in the cages are: grouper *E. tauvina*, 80-90 mm; koth *Otolithus biauritus*, 140-150 mm; silver pomfret *Pampus. argenteus*, 80-90 mm; dara *Polynemus indicus*, 110-120 mm; ghol *Pseudoscaiena diacanthus*, 80-90 mm and spiny lobster *Panulirus polyphagus*, 110-130 mm. Fresh by- catch consisting of low value fish such as Bombay duck, *Coilia*, ribbonfish, *Acetes* and *Palaemon*

spp. caught in bag nets operated in the vicinity of cages are fed to the fish and lobster @ 4 kg/day.

Chennai

- Mooring and launching of the two cages were carried out in February 2010 at Chennai. For mooring the fish cage, 160 stones and for the lobster cage 190 stones, each weighing 17-20 kg was used. Stocking of the cages with lobster seed and seabass fingerlings was carried out on the 5th day of mooring.
- Ten thousand numbers of seabass seed weighing approximately 0.55 g and 3.5 cm were procured from RGCA at Sirkazhi by the end of August 2009. Due to the cannibalistic nature of the fish, size selection/ grading were carried out at regular intervals. A survival rate of about 80 % was obtained, with an average size range from 14 to 15 cm. The fingerlings were shifted to the cage in a mildly anaesthetized condition in 500 l rectangular FRP tanks under aerated condition. About 7000 fingerlings, of average size 170-250 mm were stocked in the cage in three days. The fish are being fed on pellet diets, along with trash fish and shrimp, two times a day @2-3% biomass.
- About 1000 juvenile spiny lobsters *Panulirus homarus* were collected and reared separately in 1 tonne recirculating FRP tanks with biofilters. A stock of mullet seed (*Mugil cephalus*) was also procured from Muttukadu estuary/Kelambakkam for stocking in the lobster cage. Approximately 1000 numbers of *P. homarus* seed weighing 70-100 g and 400 numbers of *Mugil cephalus* seed of 8.5-12 cm size have been stocked in the lobster cage. The lobsters are being fed on fresh clam meat@ 5% biomass.

Cage launching at Chennai

Seabass transport to cage at Chennai

Kakinada

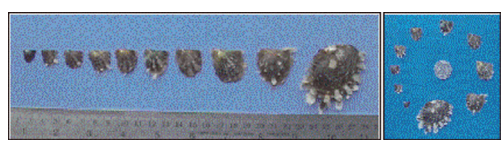
- Open sea floating cage of 6 m dia. was launched at 10 m depth in the Bay of Bengal off Uppada, Kakinada and mooring of the cage was demonstrated to the members of local fisherman co-operative society. About 4000 seabass seed (average 137 mm and 30.83 g) were reared in the seed cage in the sea off Balasore in the Orissa and transported to the Visakhapatnam Regiona Centre of CMFRI in 4 ppt seawater. The seeds were acclimatized gradually upto 25 ppt seawater within 24 h, transported and released to the cage in oxygen filled plastic cans during early hours of the day. Stocked fishes are being fed with chopped trash fish. After three months the growth attained is about 288.75 g.

Cage launching at Kakinada

FUNDING AGENCY	**Ministry of Earth Sciences (MoES)**
PROJECT TITLE	**Farming and pearl production in the black lip pearl oyster *Pinctada margaritifera* in the Andaman and Nicobar Islands**
SCIENTISTS	**K.S. Mohamed,** T.S. Velayudhan and V. Kripa
CENTRE	Port Blair

Black lip pearl oyster spat production in hatchery

- After the initial success in spat production in February 2009, trials were continued in May and November 2009. Although spat could not be obtained in the May trial due to prevailing high water temperatures, the November spawning resulted in high survival rate from trocophore to spat. The spats were shifted to specially fabricated on-farm grow-out cages and kept for further growth in Panighat Farm.



Pinctada margaritifera spat growth in 5 months in Panighat pearl oyster farm in Port Blair

Spat production

Month 2009	Spat production	Survival % (trocophore to spat)	Survival to juvenile (%)
February	25,000	24	0.6
May	Nil	-	-
November	78,000	56	18

Large-scale high density microalgal culture system developed

- In order to meet the increased demands of the hatchery for algal feeds, a high density microalgal culture system was developed by modifying the existing translucent cigarette tanks. An internal illumination system was provided to enhance cell growth and harvest. Details are provided in the table.

Type of culture	Volume of culture	No of days required for harvest	Volume of inoculum	Max. retention time of culture	*Pavlova salina* (cell/ml)	*Isochrysis galbana* (cell/ml)	*Cheatoceros* sp. (cell/ml)
Mass culture (Cigarette tank) Indoor	200 l	12 to 15	15 l	30 days	25-30 lakh	25-30 lakh	20 lakh
Mass culture Outdoor	200 l	15	15 l	20 days	15-20 lakh	20-22 lakh	15 lakh

Mabe pearl production in *P. margaritifera*

Training on mabe pearl production

New technique for continuous mabe pearl production in *Pinctada margaritifera*

- In normal mabe pearl production technique, oysters have to be sacrificed at the time of harvest. Black lip pearl oysters are a scarce natural resource in the Andman and Nicobar Islands, and therefore before the technology is transferred to end-users there is need to conserve the resources. In the new technique developed oysters need not be sacrificed. The mabes can be harvested, and a new mabe base image can be implanted in the same place repeatedly. The turnover time for a mabe pearl is usually 2 months and for a half pearl it is 4-5 months.

Training on mabe pearl production for fisherwomen SHG in Panighat

- A day long awareness and hands on training program on marine black pearl production was conducted for the fisherwomen of Panighat village at the fishermen community hall of Hope town, Port Blair on 25 August 2009.
- The Grama Panchayat Pradan of Hope Town, Shri B. Rama Murthy inaugurated the programme in the presence of Gram Panchayat Member Shri Laxminarayana. He stressed on the scope for developing this programme as an income generating scheme for fisherwomen families. The trainees were taken to the Panighat pearl oyster farm and the laboratory of the project in Marine Hill for hands-on training.

FUNDING AGENCY	**Ministry of Earth Sciences (MoES)**
PROJECT TITLE	**Demonstration and transfer of technology of marine pearl culture *(Pinctada fucata)***
SCIENTISTS	**V. Kripa,** T.S. Velayudhan, K.S. Mohamed, P.K. Asokan, P. Laxmilatha, I. Jagadis, C.P. Suja, Geetha Sasikumar
CENTRES	Mangalore, Calicut, Kochi, Tuticorin and Visakhapatnam

- A total of 15 training programmes benefitting 154 villagers of Vellpatti, Sippikulam, Kollam and Kalpeni were organized since the inception of the project. The themes included fabrication of raft and cage, mabe implantation, nucleus implantation and farm management. Training programmes were imparted to coastal villagers along Tamil Nadu, Kerala coast and Lakshadweep in different aspects of pearl culture and the details are given below

Place	Subject	No.	Period	Beneficiaries
Vellapatti (TN)	Cage fabrication	6	June, 2008 (3 days)	Senior citizens, women
Vellapatti	Mabe implantation	6	July, 2008 (3 days)	Women
Vellapatti	Mabe implantation	6	August, 2008 (3 days)	Women
Sippikulam (TN)	Raft fabrication	5	March, 2008 (1 day)	Village Youth
Sippikulam	Cage fabrication	6	April, 2009 (2 days)	Senior citizens, women
Sippikulam	Pearl farming	12	June, 2009 (2 days)	Senior citizens, women
Sippikulam	Implantation	32	June, 2009 (10 days)	Women
Tuticorin RC of CMFRI	Nucleus implantation	10	July, 2009 (2 weeks)	3 Women SHGs from Fathima Nagar, Tuticorin
Total		**83**		
Thankaserry	Cage fabrication	10	May, 2008 (2 days)	Women SHG
Thankaserry	Mabe implantation	6	Oct, 2008 (2 days)	Women SHG
Thankaserry	Raft fabrication Farm management	5	April, 2009 (1 day)	Youth
Thankaserry	Farm management	10	May, 2009 (2 days)	Women SHG
Thankaserry	Mabe implantation	6	June, 2009 (2 days)	Women SHG
Thankaserry	Mabe implantation	6	July, 2009 (2 days)	Women SHG
Total		**43**		
Kalpeni	Marine pearl culture	28	Jan, 2010	Villagers (youth)
TOTAL		**154**		

Pearl culture training in Tamil Nadu

- A 10-day training programme was organized at Sippikulam in June, 2009 on mabe pearl production. In the first phase of training, 32 women were trained in cage fabrication, image preparation and image implantation. Of these, ten persons were selected for the secondary level of training. At Vellapatti, another fishing village near Tuticorin, women were trained in mabe implantation.

Nucleus implantation training at Tuticorin Research Centre

- Two-weeks long training programme on pearl surgery was conducted from 20.07.09 at Tuticorin Research Centre of CMFRI. Women SHG members from Punnakayal, Fathima Nagar colony and Roche park colony were participated in the programme. The best four seeders (pearl surgery technicians are called seeders) from the group were selected to enter the second phase of training.

Pearl culture training programme in Kerala

- Six training programs were organized in mabe implantation, cage fabrication and pearl oyster farming for 43 villagers. Of these, eight women and their families were selected for participatory programmes.

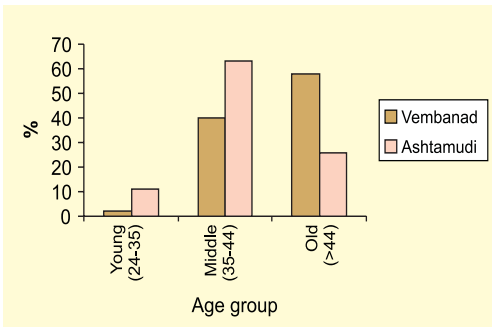
Pearl culture training programme in Kalpeni, Lakshadweep

- A training programme on nucleus and mabe implantation was organized at Kalpeni in Lakshadweep from 1st to 15th January, 2010 in collaboration with the Department of Fisheries, Lakshadweep Islands. About 28 youth participated in the programme.

FUNDING AGENCY	**Department of Science and Technology (DST)**
PROJECT TITLE	**Development of shallow water grow-out techniques for the Corbiculid clam *Villorita cyprinoides* (Gray) and for the Venerid clam *Paphia malabarica* (Chemnitz)**
SCIENTISTS	**N. Suja** and K.S. Mohamed
CENTRE	Kochi

Study on black clam fishery and socio-economic conditions of black clam fishermen

- A survey among 240 randomly selected clam fishermen from nine black clam fishing villages around Vembanad Lake was conducted to understand the fishery, its problems, demographic and socio-economic characteristics. The age of the clam fishermen ranged from 24 to 79 years. The survey revealed that the present youth express a lack of interest in clam fishing mainly due to the low returns compared to other employment opportunities. The fishermen work for an average of 20 days in a month. One kilogram of meat fetches Rs. 28- 60 depending on the size of the meat. It has been observed that the clam fishery is affected by ecological problems and the clam fishing community face health hazards, marketing problems for shell and meat, low financial assistance *etc*.



Age group of clam fishermen around Vembanad lake, Kerala

Black clam lime shell industrial co-operative societies

- The role of Black clam co-operative societies in the fishing and trade of black clams were also figured. The lime shell industrial co-operative societies are located in Kottayam and Alappuzha districts in Kerala. The societies collect the shell from fishermen at the rate of Rs.28-31/ kg and earn a margin from the sale of shells which forms the working capital for the society. The societies are involved in the implementation of welfare schemes for the members based on their fishing output.

Study on short neck clam fishery and socio-economic conditions of short neck clam fishermen

- Fishing is mainly done by methods such as the hand dredge operated from a dug out canoe, two divers collecting clams from a canoe by alternate diving, canoe with one diver and by hand picking from shallow water. The clam meat is sold to agents at the rate of Rs.38/ kg who sell it to export processing plants. The meat is frozen in blocks and exported. The shell is also collected by agents at the rate of Rs. 2.25 per kg and sold to cement or carbide factories. The fishermen observe a ban on the short neck clam fishing during December-January, the breeding season of the clam, as a self imposed regulatory

Fishing of short neck clam at Ashtamudi Lake

measure which ensures sustainability of the fishery. There are no co-operative societies functioning at Ashtamudi area for short neck clam lime shell trade.

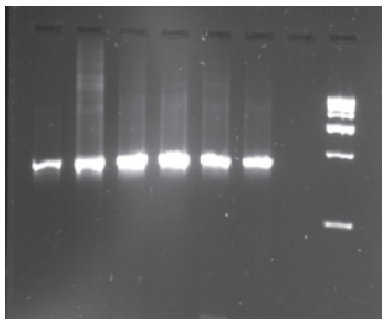
FUNDING AGENCY	**Indian Council of Agricultural Research (ICAR)**
PROJECT TITLE	**Seed production in agricultural crops and fisheries**
SCIENTIST	**K. Madhu**
CENTRE	Kochi, Mandapam, Vizhinjam, Calicut, Tuticorin and Visakhapatanam

- ICAR mega seed project is functioning at CMFRI Cochin, Mandapam, Vizhinjam, Calicut, Tuticorin and Visakhapatanam. At Cochin, seed production of marine ornamental fishes such as *Amphiprion percula, A. ocellaris* and *Premanas biaculeatus* were carried out, and the seed sold through ATIC. At other centres seed production of *A. ocellaris, Premanas biaculeatus, Pomacentrus caeruleus, Chryseptera cyanea* and *A. percula*, mussel and shrimp were carried out.

Seed project unit at CMFRI Headquarters

Marine Biotechnology

FUNDING AGENCY	**National Agricultural Innovative Project (NAIP)**
PROJECT TITLE	**Bioprospecting of genes and allele mining for abiotic stress tolerance**
SCIENTISTS	**K.K. Vijayan,** V. Srinivasa Raghavan and P.C. Thomas
CENTRE	Kochi



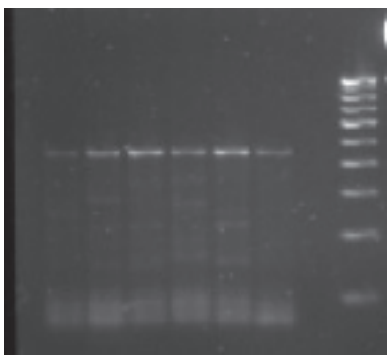
Agarose gel electrophoresis of 18S rDNA gene

Isolation and culturing of microalgae

- Microalgal samples were collected from salt pans and seawater from Tuticorin, Chennai (Pulicat Lake, Kovalam and Mahabalipuram), Kollam, Vizhinjam, Calicut and Goa.
- Isolation of algae was done using serial dilution, agar plating and micropipette method. The isolated strains were identified morphologically under a microscope. Culturing of algae was done using f/2 and Walne's seawater medium.
- Freshwater *Spirulina* strain (*Arthospira platensis*) was grown in higher salinity using f/2 and Paoletti media at 1, 15 and 30 ppt salt concentration and the protein and fatty acid profiles were studied. The growth of *Spirulina* was better in Paoletti medium due to alkaline pH and higher bicarbonate ions than f/2 medium.
- The lipid content increased slightly at 15ppt as compared to cultures in freshwater and 30 ppt salt concentration. In f/2 medium, there was an apparent increase in PUFA content at 30ppt (46.75%), but in Paoletti medium, the PUFA content decreased from 69% to 66%. The overall quality of PUFA profile was better in Paoletti medium than f/2 medium. The long chain fatty acids predominated at higher salinities. The protein content significantly increased at higher salinities in both the media.

DNA extraction and strain identification

- DNA was extracted from 54 isolates of microalgae using modified lysozyme and proteinase K method. The confirmation of species identity was done using molecular taxonomy method.
- The 18S rDNA gene was amplified, sequenced, analyzed using BLAST and the results showed 100% similarity for *Nannochloropsis* sp., 99% for *Chaetoceros* sp., 95% similarity for *Chlorella* and *Isochrysis* sp.



cDNA amplification of sodium dependent phosphate transferase (SDPT) gene

Allele mining in microalgae

- Primers were designed for the amplification of lycopene-ß- cyclase, omega–3–desaturase, calmodulin, sodium dependant phosphate transferase (SDPT), desaturase-D, chloroplast acyl transferase and C-20 elongase genes.The desaturase-D gene gave a good amplified product in *Spirulina* sp. and has been sent for sequencing. RNA isolation has been standardized with *Dunaliella* sp. and cDNA was synthesized from mRNA isolated from above said strain. Sodium Dependant Phosphate Transferase (SDPT) gene was amplified from cDNA of *Dunaliella* sp. which gave an amplified product of 450bp.

FUNDING AGENCY	**Department of Biotechnology (DBT)**
PROJECT TITLE	**Development of species specific DNA markers in economically important shellfish species green mussel (*Perna viridis*) and edible oyster (*Crassostrea madrasensis*) for their application in farming and resource management**
SCIENTISTS	**K.K. Vijayan,** P.C. Thomas, K.S. Mohamed and A. Gopalakrishnan
CENTRE	Kochi

Development of species-specific primers

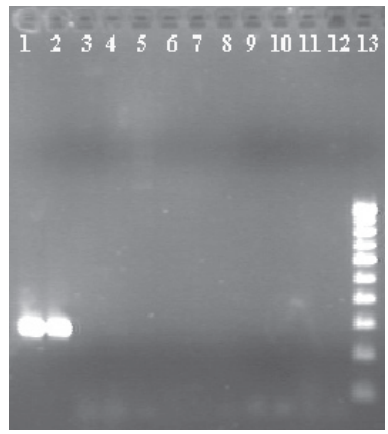
- Based on the sequence information generated for CO1 gene (FJ428750 to FJ428758), species-specific primers were designed for *C. madrasensis* and *P. viridis*. Two pairs of internal primers having conserved regions within the species and variable regions among other related species were designed using the Primer-BLAST software with the data obtained from ClustalW analysis. Using the two sets of primers, PCR reactions were standardized and out of the two pairs designed, the more specific pair was selected by PCR analysis and used further for plankton simulation works.

Details of species specific primers designed for *P. viridis*

Primer name	Primer sequence	T_m
PVCO1 F31	GTT AAT GGG GAG AAG GCT TA	58
PVCO1 R290	TAA GTA AGT ACA AAG CAT TAG GTG	58
PVCO1 F265	GGC ACC TAA TGC TTT GTA CT	58
PVCO1 R539	TTA AAA GAA CAC CGG TTA CG	58

Details of PCR conditions for the specific primers of *P. viridis*, PVCO1 F265 and R539

Total reaction volume	Reaction mix composition	Thermal conditions of PCR	
	1X Sigma Standard Taq buffer	95^0 for 03 min	
	200µM dNTPs	95^0 for 30 sec	
25µl	0.2 µM of each primer	58^0 for 30 sec	40
	1U Sigma Taq polymerase	72^0 for 30 sec	cycles
	~ 50ng of Template DNA.	72^0 for 05 min	



Agarose gel image showing the PCR product of ~270bp which was obtained using the species specific CO1 primers designed for Perna virdis, PVCO1 F265 and PVCO1 R539

Species specific primers in *P. viridis*

- The specific primers designed for *P. viridis,* PVCO1 F265 and PVCO1 R539 produced an amplicon of ~270bp length. The specificity of the primers designed was evaluated with the related bivalves and other organisms which occur in the same niche. PCR reactions consistently amplified the green mussel, *P. viridis* sample, where all the other tissues from related bivalves and other unrelated organisms did not give PCR amplification and were negative.

Species specific primers in *C. madrasensis*

- The specific primers designed for *C. madrasensis* CMCO1 F66 and CMCO1 R315 produced a PCR amplicon of ~249bp length. The specificity of the primers designed was evaluated with a series of PCR reactions with the related bivalves and other organisms which occur in the same niche. PCR reactions consistently amplified the edible oyster, *C. madrasensis* sample, where all the other tissues from

related bivalves and other unrelated organisms did not gave PCR amplification and were negative (Fig. 3).

Details of species specific primers designed for *C. madrasensis*

Primer name	Primer sequence	T_m
CMCO1 F66	GCT GAA GGC TGT ATA ACC CG	63
CMCO1 R315	GAA TAA GTT GAT AGC GGC GG	63
CMCO1 F77	TAT AAC CCG GGG GCT AAG TT	63
CMCO1 R360	GAA TAA GTT GAT AGC GGC GG	63

Agarose gel image showing the PCR product of ~249bp which was obtained using the species specific CO1 primers desiged for C. madrasensis, CMCO1 F66 and CMCO1 R315

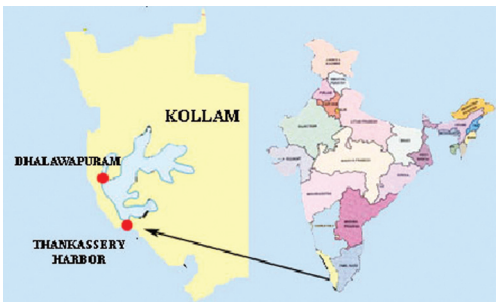
Details of PCR conditions for the specific primers of *C. madrasensis*, CMCO1 F66 and R315

Total reaction volume	Reaction mix composition	Thermal conditions of PCR	
25µl	1X Sigma Standard Taq buffer	95^0 for 03 min	
	200µM dNTPs	95^0 for 30 sec	
	0.2 µM of each primer	58^0 for 30 sec	40
	1U Sigma Taq polymerase	72^0 for 30 sec	
	~ 50ng of Template DNA.	72^0 for 05 min	cycles

Evaluation of the specific primers in plankton samples

Plankton collection

- Plankton samples were collected from the locations abundant with mussel and oyster beds (Thalassery Harbour and Dhalawapuram, Kollam, Kerala) during the breeding season for green mussel (July to September 2009). Net with 80µ mesh size and a mouth opening of 20 cm in diameter was used for collecting plankton. It was operated about about 1foot below the water surface and towed approximately 100 m with a canoe.
- Representation of the larval stages, trochophore, veliger and umbo in the plankton samples is directly related to the probability of spat settlement.



Collection sites - Dhalawapuram, situated in Ashtamudi Lake and Thankassery Harbour of Kollam district, Kerala

PCR identification of *P. virdis* and *C. madrasensis* using simulated plankton samples

The plankton samples collected were observed under a compound light microscope at 10X and 40X optical zoom. The larval stages of bivalves were absent in the samples collected. In the absence of bivalve larvae, a simulation study of plankton samples were initiated using veliger larvae of *P. viridis* (produced in CMFRI hatchery), and is in progress.

FUNDING AGENCY **Department of Biotechnology (DBT)**

PROJECT TITLE **Development of genetically improved strains of brine shrimp *Artemia* using quantitative and molecular genetic tools**

SCIENTISTS **P.C. Thomas,** K.K. Vijayan, J. Jayasankar and Kajal Chakraborty

CENTRE Kochi

Survey and collection of indigenous *Artemia*

- Exploratory survey for collection of *Artemia* was carried out in the hyper saline waters of the west and east coasts.

List of *Artemia* collected and geographical origin

State	Location / Strain code	Nature of sample	Type
Gujarat	Mithapur (GMJ)	*Artemia* and Cyst	Bisexual
	Nanganvadi (GNM)	*Artemia*	Bisexual
Rajasthan	Sambhar and Didwana Lakes	Nil	
Maharashtra	Meera Road, Thane, Uran, Vassai Road, Bhayender	Nil	
Tamil Nadu	Kelambakam (CKF)	*Artemia* and Cyst	Bisexual
	Marakkanam (TTM)	*Artemia* and Cyst	Bisexual
	Thamaraikulam (TNM)	Cyst	Bisexual
	Tuticorin (TTJ)	*Artemia* and Cyst	Bisexual
	Vedaranyam (VDA)	*Artemia* and Cyst	Bisexual

Identification of parthenogenetic/ sexual strains

- Since the indigenous artemia have been reported to be parthenogenetic, the strains collected were checked for parthenogenesis.
- No parthenogenetic mode of reproduction was observed.
- Morphological examination for sexual dimorphism revealed that indigenous stock was bisexual. They were either males with claspers and distal penis or females with brood pouch.
- Cross breeding trials revealed sexual mode of reproduction.
- Molecular tools were used for taxonomic identification. BLAST search using the ITS1 and CO1 sequences of the indigenous strains have shown 99 % homology to *Artemia franciscana.*
- The study revealed the invasion of Indian salterns by bisexual *Artemia franciscana* and the disappearance of native parthenogenetic strains.
- Naturalised strains of *A. franciscana* have been established in the hyper saline waters of India.

Characterization of *Artemia*

- Cyst biometry recorded after their hydration from both the indigenous and exotic strains are presented below.

Cyst biometry of indigenous *Artemia* strains

Strain	Mean cyst diameter (im)
Mithapur (GMJ)	226.16±14.02
Nanganvadi (GNM)	228.32± 11.39
Kelambakam strain (CKF)	224.84±14.81
Vedaranyam strain (VDA)	231.56±15.62
Tuticorin strain (TTJ)	223.35±11.57
Thamaraikulam(TNM)	236.37±19.00
Marakkanam (TTM)	219.63±10.10
Cyst biometry of exotic strains	
***Artemia* species**	**Mean cyst diameter (im)**
Artemia franciscana (SFB strain)	239±13.92
A. franciscana Vietnam strain (VVC)	238±10.84
Artemia tibetiana (TBS)	319±24.74
Artemia salina (ASL)	261±17.35

- The variations in cyst diameter of the Indian strains and the reference strain of *Artemia franciscana* were not significant ($p<0.05$). Cysts of *Artemia tibetiana* and *A. salina* were significantly bigger ($p>0.05$) than the Indian strains.

Molecular characterization

Mitochondrial DNA analyses

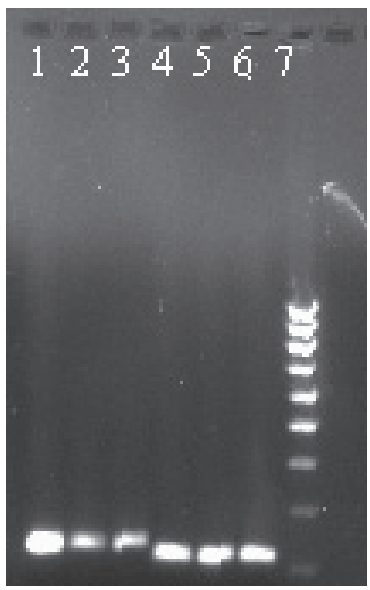
- Mitochondrial gene cytochrome oxidase sub-unit I (CO1) was PCR amplified with the specific primers and the product sequenced.

Nuclear DNA analyses

- ITS1 was PCR amplified with universal primers PTF and PTR and sequenced. Basic alignments search tool (BLAST) was used for homology search with similar sequences in the NCBI data base.

Sequence characteristics of ITS1

- The sequence characteristics of ITS1 given below indicate that the present stock of indigenous artemia is relatively new and under expansion.



Agarose gel image of Artemia hsp 22 and ? actin gene amplified from cDNA Lane 1: cyst hsp, Lane 2: nauplii hsp, Lane 3: adult hsp, Lane 4: cyst? actin, Lane 5: nauplii ? actin, Lane 6: adult ? actin and Lane 7 100 bp DNA ladder

Length of the sequence (bp)	1048
Invariable sites (bp)	1018
G+C content range (mean)	29.4 ; 18.4 (23.9)
Singleton variable sites	11
Parsimony informative sites	5
Variable (polymorphic) sites	16
Total number of InDel sites	12
Average InDel length	1.077
Tajima's D	-2.22161
Sequence conservation C	0.984

- Partial sequence of ITS1 and CO1 of the indigenous *Artemia* strains and *A. franciscana* were deposited in the NCBI Gen Bank.

Sequence deposited with Gen Bank from the project

Strain	Gene/ region	No. of deposits	GenBank Accession number
CKF	ITS1	2	GU323289&GU323317
CKF	CO1	1	FJ467923
GMJ	ITS1	2	GU323290-91
GMJ	CO1	1	FJ467924
GNM	ITS1	4	GU323292-95
GNN	ITS1	2	GU323296-97
TMM	ITS1	2	GU323300-01
TNM	ITS1	6	GU323302-07
TTJ	ITS1	5	GU323308-12
VDA	ITS1	4	GU323313-16
VDA	CO1	1	FJ467924
SFB	ITS1	2	GU323298-99
SFB	CO1	2	FJ467925
Total		**34**	

Genetic distance among the native strains

- Pairwise genetic distances between the different indigenous strains were very low, ranging from 0 to 0.01. Similarly, the pairwise genetic

distances between these and the reference strain *A. franciscana* were also negligible ranging from 0 to 0.01 indicating that all the native *Artemia* sp. belong to the species *Artemia franciscana*.

Mean genetic distance of indigenous strains from others

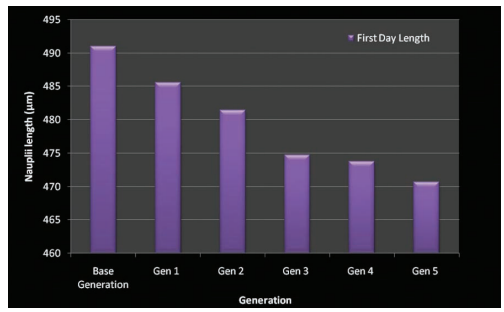
Artemia species	Mean genetic distance	Minimum	Maximum
Artemia franciscana	0.0045	0.001	0.006
Artemia salina	0.2074	0.18	0.228
Artemia sinica	0.1418	0.137	0.147
A.parthenogenetica	0.1300	0.126	0.135
Artemia persimilis	0.5364	0.53	0.554
*Artemia sp.*China	0.1335	0.128	0.139
Artemia sp. (Kazakistan)	0.1325	0.128	0.137
Artemia tibetiana	0.1300	0.126	0.135
Artemia urmiana	0.1406	0.136	0.145

Phylogentic analysis

- Phylogentic tree constructed by the Neighbour Joining analysis based on the ITS-1 region grouped the indigenous strains and the *Artemia franciscana* into the same clade. Topologies of the phylogenetic tree revealed the close relation of indigenous *Artemia* strains with *A. franciscana* which could be distinguished from other species.

Functional gene diversity

- Cysts withstand temperatures from 1 to 55° C and salinities from 3 to 300 ppt, which is mediated through molecular chaperones: small heat shock proteins (hsp)
- Once hatched, it is postulated that these genes are down regulated in nauplii.
- Hsp22 from native strains were first PCR amplified with hsp specific primers, product sequenced and BLAST searched for confirmation.



Artemia nauplii length at different generations

Characterization of hsp22 genes

- While hsp22 of GMJ exhibited 100% similarity with *A. franciscana* the CKF exhibited transition (silent mutations) at two positions.
- Partial sequence of a 238 bp segment of the hsp 22 of CKF and GMJ strains have been deposited in NCBI Gen Bank with Accession Nos. GU377282 and the GU377283.
- Transcription levels of the hsp in different life stages were studied using real time PCR.
- Expression levels of hsp22 in the cyst were found to be very high compared to other stages.

Biochemical profiling

- Proximate composition, protein, carotenoids, lipids and fatty acid content were analyzed for all the strains.
- Biochemical contents revealed significant differences among different life stages, the nauplii having higher levels making them a suitable live feed for larviculture.

Selective breeding

- Selective breeding for naupliar size reduction is being carried out.
- The artemia are pair mated, nauplii are pedigree hatched and used for selection by individual selection method based on size. Selection responses were estimated from five generations and it was observed that the naupliar size has been reduced from 491 µ to 470 µ.
- Correlated response showed length reduction on third day from 1.28 mm to 1.19 mm and on sixth day from 3.68 mm to 3.10 mm

FUNDING AGENCY **Department of Biotechnology (DBT)**

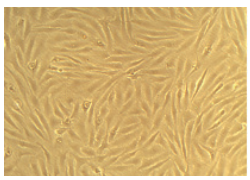
PROJECT TITLE **Establishment and characterisation of cell lines from selected marine food fish and ornamental fish**

SCIENTISTS **K.S. Sobhana,** K. Madhu, Boby Ignatius and N.K. Sanil

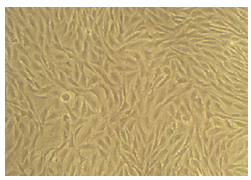
CENTRE Kochi

Initiatiion of primary cultures and passaging to develop cell lines

***Dascyllus trimaculatus* (Three spot damsel)**



DT1CpTr at passage 39



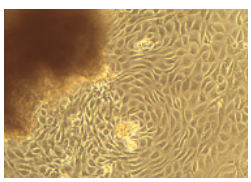
DT1F4Ex at passage 37

- Out of the 6 cell culture systems developed from various tissues of *D. trimaculatus*, DT1CpTr, DT1CpEx and DT1F4Ex have reached various passage levels as shown in the table. The cell culture systems derived from gill (DT1G2Ex), spleen (DT1Sp Ex) and heart explants (DT1HEx) were lost due to microbial contamination.

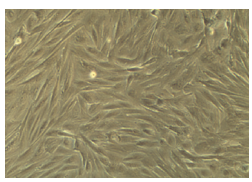
Cell culture systems developed from *Dascyllus trimaculatus*

Code No.	Tissue of origin	No. of passages
DT1CPTr	Trypsinised caudal peduncle	39
DT1CPEx	Caudal peduncle explant	32
DT1F4Ex	Fin explant	37

***Epinephelus merra* (Honeycomb grouper)**



HC2H2Ex in primary culture

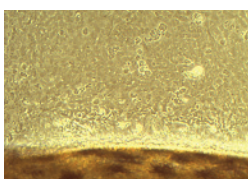


HC2H2Ex at passage 3

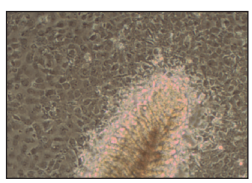
- In the initial attempt to develop cell cultures from *E. merra*, out of the 5 cell culture systems derived (HC1F2Ex, HC1G1Ex, HC1KEx, HC1SpEx and HC1H2Ex), except HC1H2Ex all the others perished in the initial levels of passages. HC1H2Ex reached 35 passages and was lost due to severe rounding of the cells. Therefore a second attempt was made to initiate primary cultures from various tissues by explant method as well as by tryspinisation. Successful cell cultures have been developed from caudal peduncle, brain, gill, liver, fin, and heart tissues as given below in the table.

Cell culture systems derived from *Epinephelus merra*

Code No.	Tissue of origin	No. of passages
HC2CpTr	Trypsinised caudal peduncle	6
HC2BrTr	Trypsinised brain	4
HC2G1Tr	Trypsinised gill	4
HC2L1Tr	Trypsinised liver	3
HC2G1Ex	Gill explant	2
HC2H2Ex	Heart explant	3
HC2F3Ex	Fin explant	1



HC2F3Ex in primary culture



HC2F3Ex in primary culture

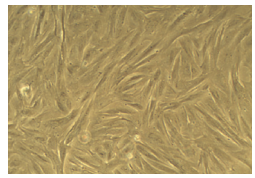
***Rachycentron canadum* (Cobia)**

- Totally four attempts were made to initiate cell cultures from *R. canadum*. All the primary cultures from the first two attempts were

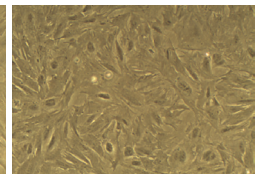
lost due to microbial contamination. From the third attempt, except RC3Br1Tr developed from the brain tissue, all other cultures were lost. In the fourth attempt successful cell cultures have been initiated from the fin, gill, caudal peduncle, liver and heart tissues, the details of which are shown in the table.

Cell culture systems developed from *Rachycentron canadum*

Code No.	Tissue of origin	No. of passages
RC3 Br1Tr	Trypsinised brain	5
RC4 F2Tr	Trypsinised fin	7
RC4 G1Tr	Trypsinised gill	3
RC4CpTr	Trypsinised caudal peduncle	2
RC4L2Tr	Trypsinised liver	1
RC3 H1Tr	Trypsinised heart	1



HC2L1Tr at passage 3



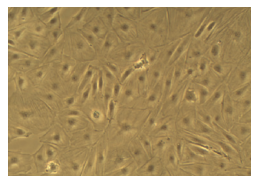
HC2BrTr at passage 4

***Siganus canaliculatus* (Rabbit fish)**

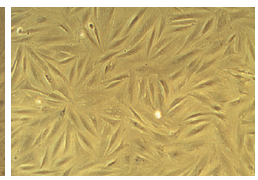
- Eight attempts were made to initiate cell cultures from *S. canaliculatus*. Though successful primary cultures were developed in most of the attempts, this cells were lost at various levels of passages. The details of successful cell culture systems developed in the 8th attempt which are being passaged at present are given in the table.

Cell culture systems developed from *Siganus canaliculatus*

Code No.	Tissue of origin	No. of passages
SC8F1Tr	Trypsinised fin	5
SC8Sp2Tr	Trypsinised spleen	3
SC8G1Tr	Trypsinised gill	3
SC8H1Tr	Trypsinised heart	3
SC8Br1Tr	Trypsinised brain	4
SC8Cp1Tr	Trypsinised caudal peduncle	3
SC8KTr	Trypsinised kidney	3



RC3Br1Tr at passage 5

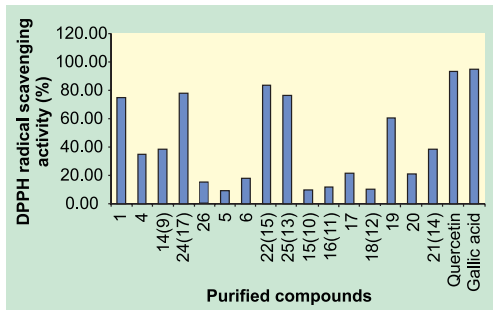


RC4 F2Tr at passage 7

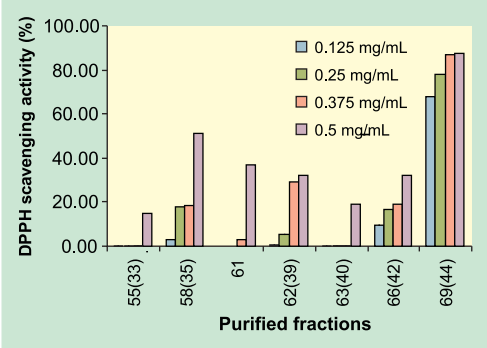
FUNDING AGENCY Department of Science and Technology (DST)
PROJECT TITLE Characterization of novel antioxidant from red and brown seaweeds from Gulf of Mannar
SCIENTIST Kajal Chakraborty
CENTRE Kochi

Bioassay guided purification of the crude fractions using different chromatographic techniques and *in vitro* antioxidant activity assay of the purified fractions

- Brown seaweed *Sargassum longifolium* was processed to prepare the crude solvent as well as aqueous extracts and chromatographed to obtain purified compounds that were evaluated for the ability of radical-scavenging activity which exhibited potential antioxidant activity (EC_{50} 0.16-1.35 mg ml^{-1}). Compound 22 (83.63 ± 0.08 %) exhibited highest antioxidant activity. Among others, compounds 24 (78.20 ± 0.24%)> 25 (76.53 ± 0.35%) and > 1 (74.78 ± 0.07%) are potential compounds. The relative activities have been presented in the figure.
- Chromatographically purified compounds from *Turbinaria ornata* 53(31) (74.01 ± 0.36 %) and 43 (70.35 ± 0.08%) were highly potent to scavenge DPPH free radical in comparison with other compounds with the same dose (0.5 mg ml^{-1}).



DPPH radical scavenging activity (%) of purified compounds from *S. longifolium*



DPPH radical scavenging activity (%) of different purified fractions from *A. spicifera* and *L. papillosa*

- Red seaweed *Acanthophora spicifera* was chromatographed to yield compound 69(44), which was found to be most effective (87.62 ± 0.45%) free radical scavenger followed by 58(35) (51.35 ± 0.03%). Compound 103(56) from *Laurencia papillosa* was found to exhibit strong antioxidant activity, and interestingly its activity was higher than the positive controls quercetin and gallic acid, which are the well-known synthetic antioxidants. Compounds 103(56), 105(59), and 97 were found to be highly effective to scavenge DPPH radical (97.82, 85.80, and 83.95%, respectively) as illustrated in the figure.

- DPPH radical scavenging activity (%) of different purified fractions was obtained from *A. spicifera* (0.125-0.5 mg ml^{-1}) and *L. papillosa* (0.5 mg ml^{-1}). Two purified fractions were obtained from n-hexanic extract among which 72(47) was found to be highly effective to scavenge DPPH free radical (EC_{50} 0.23 mg ml^{-1}) in brown seaweed *Padina gymnospora*.

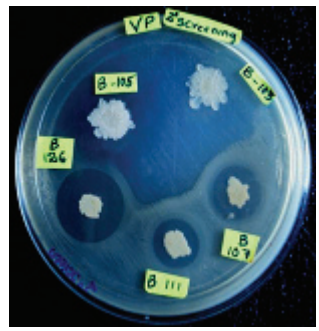
- Among the purified compounds obtained from CH_2Cl_2 fraction of *P. gymnospora*, 73 (EC_{50} 0.37 mg ml^{-1}) was found to be highly effective antioxidant (EC_{50} 0.34 mg ml^{-1}).

Marine Microbiology

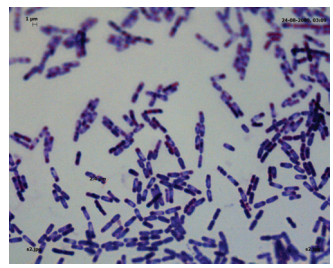
FUNDING AGENCY	**ICAR -AMAAS**
PROJECT TITLE	**Application of microorganisms in agriculture and allied sectors (AMAAS)** **Sub-project: Development of a library of putative probionts from marine environment belonging to the genus *Pseudomonas, Micrococcus* and *Bacillus* for application in mariculture systems**
SCIENTISTS	**K. K. Vijayan,** Kajal Chakraborty and Subhadeep Ghosh
CENTRES	Kochi and Veraval

Useful bacteria from south-west coast of India

- More than 2000 isolates were isolated from different seaweeds. Among them, 53 were identified biochemically to species level by conventional methods. About 62% (33 isolates) belonged to *Bacillus* spp., 11% to *Pseudomonas* spp., 4% to *Micrococcus* spp. and the rest Enterobacteriacae.
- DNA isolation and quantification completed in 35 isolates. BLAST results showed that the sequences of bacterial 16S gene with 99% similarity with the sequences of *Bacillus subtilis* and *Pseudomonas putida*. About 24 isolates of *Bacillus* spp. including 3 isolates of *Pseudomonas* spp. were found to give zone of activity (antimicrobial) against *V. parahaemolyticus.*
- *Bacillus alvei* isolated from *Laurencia papillosa* exhibited a zone of inhibition of 30-31 mm against *V. parahaemolyticus* ATCC 17802. *B. subtilis* from *Padina* sp. possess antibacterial activity against *V. vulnificus* (IZ 25 mm). *B. subtilis* isolated from *Hypnea valentia* possess antibacterial activity against *V. parahaemolyticus* (IZ 18-19 mm). The potential isolates have been bioprospected to isolate antibacterial molecules.
- Bioassay-guided chromatographic purification of the antibacterial principles from the crude microbial extracts was carried out and the results revealed that EtOAc fraction of 24 h broth culture furnished major component at R_f 0.5-0.6. The CH_2Cl_2 fraction (1:5 CH_3COOEt in *n*-hexane) showed R_f values of 0.4-0.8.
- *B. subtilis* from *Sargassum longifolium* has high antibacterial activity against *V. parahaemolyticus* ATCC 17802 (IZ 20 mm). Twenty four hour broth culture was fractionated by EtOAc to furnish compound with R_f values of 0.2-0.3 with antibacterial activity. Structural characterization by infrared spectroscopy revealed the principle components in bioactive extract to possess conjugated carbonyl moieties. The purified components are being characterized by NMR and mass spectroscopic methods to understand the bioactive principles responsible for activity.



Antibacterial assay of bacterial isolates, *B. subtilis* against *V. parahaemolyticus*

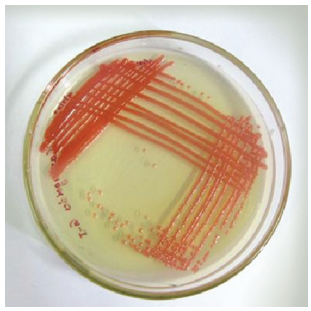


B. subtilis isolated from brown seaweed *Sargassum longifolium* under gram staining

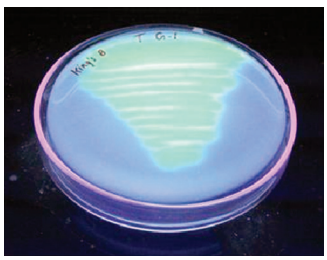
Clearance zone (due to antibacterial activity) of EtOAc extract from *Bacillus subtilis* isolated from seaweed *S. longifolium*

FUNDING AGENCY	**ICAR -AMAAS**
PROJECT TITLE	**Application of microorganisms in agriculture and allied sectors (AMAAS):** Microbial Diversity and Identification - Fish microbes
SCIENTIST	**Imelda Joseph**
CENTRE	Kochi

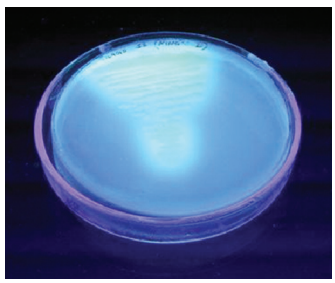
- Fish samples were collected from different centres at Tamil Nadu (Mandapam, Kanyakumari, Thoothukudy and Chennai) and from Calicut, Kerala.



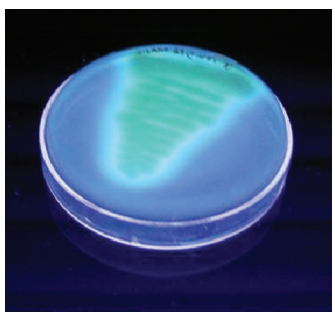
Pigmented colonies- *Carangoides* G-1 *(Flavobacterium* sp.*)*



Fluorescent colonies: *Raconda* G-1 (*Pseudomonas* sp.)



Fluorescent colonies - *Sillago* S-2 (*Pseudomonas* sp.)



Fluorescent colonies - *Sillago* G-3 (*Pseudomonas aeruginosa*)

- Twenty two bacterial strains have been isolated from five marine fishes (*Siganus* sp., *Carangoides* sp., *Leiognathus* sp., *Caranx* sp. and *Sillago* sp.) collected from Mandapam, Tamil Nadu. *Bacillus* and *Pseudomonas* spp. were the predominant skin isolates. While, gills harbored species of *Acinetobacter, Arthrobacter, Bacillus, Enterobacteriaceae, Flavobacterium* and *Pseudomonas*. The visceral isolates included *Arthrobacter, Bacillus*, *Enterobacteriaceae* and *Pseudomonas*.

- Twenty five bacterial strains have been isolated from four marine fishes (*Sardinella* sp., *Cephalopholis* sp., *Cynoglossus* sp. and *Acanthurus* sp.) collected from Kanyakumari, Tamil Nadu. *Alcaligenes, Bacillus, Pseudomonas* and *Vibrio* spp. were the predominant skin isolates. While, gills harbored *Acinetobacter, Aeromonas, Alcaligenes, Arthrobacter, Bacillus, Pseudomonas* and *Staphylococcus* spp. and visceral isolates included *Arthrobacter, Micrococcus, Pseudomonas, Staphylococcus* and *Streptococcus* spp.

- Eighteen bacterial strains have been isolated from five marine fishes (*Sphyraena* sp., *Carangoides* sp., *Terapon* sp., *Rastrellinger* sp. and *Megalaspis* sp.), collected live from Thoothukudy, Tamil Nadu. Phenotypic characterization completed. *Acinetobacter, Bacillus, Enterobacteriaceae* and *Pseudomonas* spp. were the predominant skin isolates. While, gills harboured *Arthrobacter, Bacillus, Enterobacteriaceae, Pseudomonas* and *Vibrio* spp. and visceral isolates were *Aeromonas* and *Bacillus* spp.

- Thirty-seven bacterial strains have been isolated from five marine fishes (*Cynoglossus* sp., *Pseudorhombus arsius, Raconda russeliana, Daysciaena albida* and *Nematalosa nasus*), collected live from Chennai, Tamil Nadu. *Arthrobacter, Bacillus, Micrococcus, Pseudomonas, Staphylococcus* and *Vibrio* spp. were the predominant skin isolates. While, gills harbored *Alcaligenes, Arthrobacter, Bacillus, Enterobacteriaceae, Pseudomonas* and *Vibrio* spp. The visceral isolates included *Arthrobacter, Micrococcus, Planococcus* and *Staphylococcus* spp.

- Ten bacterial cultures comprising halophilic, pigmented, fluorescent and heat resistant bacteria were identified using 16S rRNA sequence analysis. The bacterial cultures were submitted to the AMAAS nodal centre (NBAIM) along with their sample reports during September 2009. These strains are *Sporosarcina saromensis* (GenBank Accession No. AB243864), *Planococcus maritimus* (GenBank Accession No. EU624446), *Arthrobacter* sp. (GenBank Accession No. EU797642), *Halomonas aquamarina* (GenBank Accession No. EU440965), *Halomonas marina*; (GenBank Accession No. AJ306890), *Stenotrophomonas* sp. (GenBank Accession No. EU816585), *Bacillus* sp. ZH4 (GenBank Accession No. EU2367506), *Pseudomonas aeruginosa* (GenBank Accession No. FJ665510), *Bacillus marisflavi* (GenBank Accession No. DQ105973). These 10 cultures have been submitted to NBAIM, with passport data.

Value Chain Project

FUNDING AGENCY	**National Agricultural Innovative Project (NAIP)**
PROJECT TITLE	**A value chain on oceanic tuna fisheries in Lakshadweep sea**
CONSORTIUM PARTNERS	CMFRI, CIFT, FSI and Department of Fisheries, Kavaratti, Lakshadweep
SCIENTISTS	**E.V. Radhakrishnan,** N.G.K.Pillai, E. Vivekanandan, R. Sathiadas, K. Sunil Mohamed, C. Ramachandran, J. Jayasankar, K.P. Said Koya, U. Ganga (CMFRI); B. Meenakumari, T.K. Srinivasa Gopal, Toms C. Joseph, Suseela Mathew, K. Ashok Kumar, P. Pravin, Reghu Prakash, M.V. Baiju, Bindu J (CIFT), K. Vijayakumaran (FSI) and C.G. Koya (Fisheries Department, Lakshadweep)

- Tuna longline fishing operations were carried out in Lakshadweep sea by engaging two 62' tuna longliners. 16 cruises each by two boats ranging from 5 to13 days were carried out. One hundred and fourty eight stations were covered and 3.74 t yellowfin tuna ranging in weight from 5 to 25 kg were caught.
- Five different types of baits were tested out of which ribbon fish and squid were found to be the most effective with 80% of the catch coming from these baits. By-catch mainly constituted sharks, marlins and sail fish.
- The tuna landing from 3 islands, Androth, Agatti and Minicoy were also monitored and collected data. An estimated 3994 t of tuna landed of which the yellowfin tuna *Thunnus albacares* formed 16%. Price information of tuna from different marketing channels was also collected.
- Four Pablo boats were modified and converted to longliners. Fishing was conducted for 158 days and 1.4 t of large pelagics including yellowfin tuna were caught.
- One value-added product (Masmin flakes) and one ready-to-serve product (Tunakure) developed. Gelatin prepared from tuna skin.
- Two Consortium Implementation Committee (CIC) and Consortium Advisory Committee (CAC) meetings were held at CMFRI, Kochi and the progress reviewed by each of the Consortium Partners.
- A statistical data collection manual was prepared and given to the scientists, scholars and enumerators.
- A training programme on trophic modeling was conducted in which 28 SRFs participated.
- A workshop on Ecolabelling was organized on 27th March 2010 in which fishery industry, fishermen, NGOs, scientists and fishery managers participated.
- 30 persons at Pullani, Kerala and 40 women from Kavaratti were trained in production of value-added products.

Agatti fishermen with an Yellowfin tuna caught in modified tuna longliner

Major achievements:
Modification and conversion of 5 pablo boats in Agatti, training of fishermen in longline fishing and processing, conducting fishing operation, standardization of process parameters for production of value-added products, production of one ready-to-serve and one value-added product from tuna, two products (a fish feed and gelatin) from tuna waste and training of women in production of value-added products.

Tunakure a value added ready to eat product prepared from tuna red meat

FUNDING AGENCY	**National Agricultural Innovative Project (NAIP)**
PROJECT TITLE	**Export oriented marine value chain for farmed seafood production using cobia *(Rachycentron canadum)* through rural entrepreneurship**
SCIENTIST	**G. Gopakumar**
CENTRE	Mandapam

Cobia fingerlings

- Successful broodstock development, induced breeding and larval production of cobia *Rachycentron canadum* was achieved for the first time in India. Larviculture protocols were developed by appropriate management of live feeds in suitable quantities and also taking into consideration the nutritional requirements of the larvae. The larvae were stocked in FRP tanks of 5 ton capacity for larviculture. The intensive larviculture tanks were provided with green water at a density of about 1x 10^5 cells/ ml and rotifers enriched with DHA SELCO at a density of 6-8 nos./ ml from 3 to 9 days post-hatch (dph). The critical stage for the larvae was 5 to 7 dph when they entirely resorted to exogenous feeding from yolk sac feeding. During this period, large scale mortality (about 80%) was noted. Thereafter, the mortality rate was moderate. From 9 to 21 dph, the larvae were fed four times daily with enriched *Artemia* nauplii by maintaining a nauplii concentration of 2-3 nos. per ml. During this period, co-feeding with rotifers was also continued due to the presence of different size groups of larvae. Green water was also maintained in appropriate densities in the larval tanks.
- From 18 dph onwards, the larvae were fed with newly hatched *Artemia* nauplii and weaning to larval inert feeds was also started as per the details given below:

Releasing of cobia fingerlings to nursery cage at Mandapam

Stage of larvae (dph)	Size of larvae (cm)	Size of feed (µ)
18 – 19	2.3 – 2.6	100-200
20 – 23	2.5 – 3.5	300-500
23 – 30	3.5 – 8.0	500-800
31 onwards	> 4.0	800-1200

- From 25 dph, grading of larvae was started. The shooters were fed exclusively with artificial feed of size 500-800 µ and 800-1200 µ. On 30 dph, three size groups of juveniles were noted with mean sizes of 10 cm (10%), 6 cm (25%) and 4 cm (65%). All the fingerlings of 10 cm length and above were stocked in nursery cages.

FUNDING AGENCY	**National Agricultural Innovative Project (NAIP)**
PROJECT TITLE	**Utilization strategy for oceanic squids (Cephalopoda) in Arabian Sea: A value chain approach**
SCIENTISTS	**K.S. Mohamed,** Geetha Sasikumar, P.K. Asokan, K.P. Said Koya, P. Laxmilatha, V. Kripa, V. Venketesan, R. Sathiadhas, R. Narayankumar and Srinivas Raghavan
CENTRES	Kochi, Mangalore, Calicut, Mandapam and Visakhapatnam

- This component 2 NAIP scheme was initiated during the year as a production to consumption approach. The following activities were carried out during the year.

Conversion of fishing trawler

- Mechanised craft: A fishing trawler (MV Titanic) of >20 m Overall Length was modified for commercial squid jigging operations. Five

numbers of micro-processor controlled squid jigging machines with pulling power 90-100 kg was installed. The accessory generator and aerial lighting system comprising of 1.5 KW halogen lamps were set for lighting.

- Motorised traditional craft: Deck modification designs of Pablo boats for hand jigging, lift netting, pair trawling and pole and line fishing finalized.

Commercial trawler MV Titanic converted to squid jigger

Training in squid jigging

- Training was imparted by Korean experts to eight fishermen and all project staff onboard the converted squid jigger (MV Titanic) on various aspects like setting the jigging lines, mounting the monofilament lure(s) on the elliptical drums, anchoring the vessel using parachute anchors, setting the jigging machines by programming the depth to which the line-end weights are to descend before line hauling *etc.*
- Length, weight measurements and maturation studies of oceanic squids were undertaken. The Dorsal Mantle Length (DML) ranged from 190-410 mm and weight from 250 to 1900 g.

Ripe female *Sthenoteuthis oualaniensis*

FUNDING AGENCY	**National Agricultural Innovative Project (NAIP)**
PROJECT TITLE	**A value chain on high value shellfishes from mariculture systems**
SCIENTISTS	**V. Kripa,** T.S. Velayudhan, K.S. Mohamed, K.K. Vijayan, P. Vijayagopal, D. Prema, R. Narayanakumar, N.K. Sanil, I. Jagadis, Kajal Chakraborthy, Joe Kizhakudan and Margaret Muthu Rethinam
CENTRES	Kochi, Tuticorin and Chennai

- In central Kerala, one full fledged oyster processing unit for the production of value added product development unit was set up in partnership with a private entrepreneur. Fourteen villagers from three villages were trained at NIFPHATT in product development following HACCP protocols.

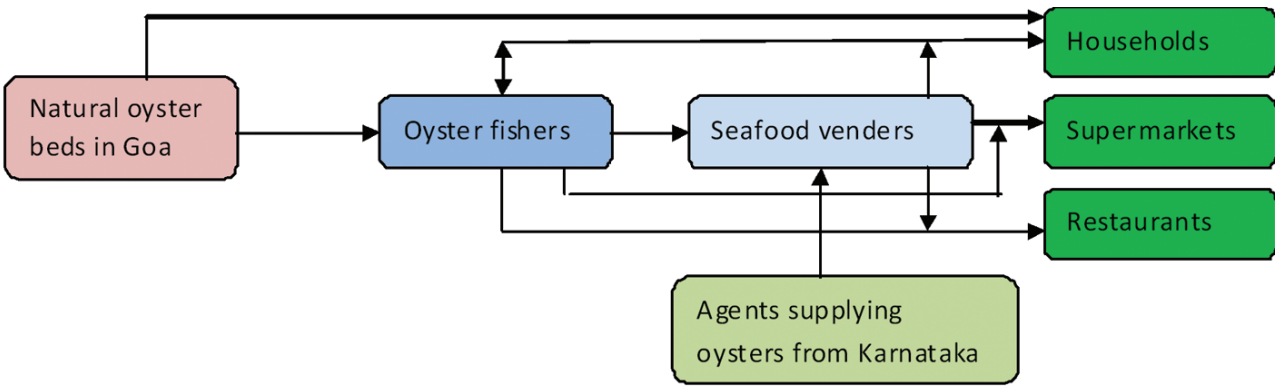
- The proximate composition and the profile of polyunsaturated fatty acids in fresh and processed oysters (Table) was estimated, This will be used for printing as "OYSTER FACT SHEET" in oyster products and for promoting oyster market.

Proximate composition of different oyster products

Name of the Product	% DM	Moisture	Crude protein	Fat (EE)	Carbohydrate CF	Carbohydrate NFE	Energy (kcal 100^{-1}g)
Frozen Oyster curry	29.91	70.09	5.02	11.08	2.59	8.98	169.89
Frozen Oyster Soup	6.13	93.87	0.56	0.54	0.02	4.42	26.39
Frozen Oyster Pickle	40.05	59.95	6.9	20.77	3.04	6.57	262.2
Frozen Oyster Pickle with vegetables	37.41	62.59	5.26	18.11	2.05	9.94	241.61
Frozen Oyster curry with vegetables	21.01	78.99	2.97	8.36	1.24	6.82	123.74
Frozen Oyster Curry	29.67	70.33	5.73	13.83	1.4	6.58	190.05
Frozen Oyster Meat	15.92	84.08	7.28	3.71	0.33	3.95	92.39
Oyster Curry	30.07	69.63	4.53	12.31	4.68	6.62	169.07
Blanched IQF Oyster	20.19	79.81	9.34	3.31	0.042	6.938	112.5

EE-Ether extract; CF-Crude fiber; NFE-Nitrogen free extract, DM-Dry matter

- The seasonal variations in hydrographic parameters (8 aboitic factors), pollution levels (7 metals) and microbial load at the commercial farm site were analyzed and recorded. The oysters were screened for occurrence of parasites to promote the product indicating the ecological health of farm site.
- More than 250 oyster broodstock were collected and induced to spawn, two million larvae produced, 2000 cultch-less spat were produced and the oysters spat were farmed in trays.
- Popularisation of oyster farming was done by conducting TOT programmes. Three training programmes were organized for nearly 470 beneficiaries in oyster farming, technical support was provided for 75 families to start oyster farms which would increase oyster production by 25%.
- Three ready-to-serve oyster products (oyster pickle, oyster curry in coconut milk, oyster curry with vegetables, oyster soup) and two ready- to-cook oyster product (battered and breaded oysters and Individually Quick Frozen oysters) were developed.
- Experiments on sand lobster seed production and farming were conducted at Chennai.



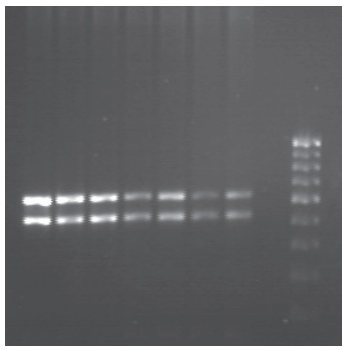
Flow chart showing market links of fresh oysters in Goa

- A baseline survey on oyster utilization and marketing was conducted in three districts of Kerala and two districts of Goa to understand the level of utilization and existing market chain for oysters.
- Oysters fished from the estuaries have a well established market in Goa. Oysters are sold either as shell-on oysters or as meat, on the same day. The price ranged from Rs.100 to Rs. 250/- per kg.
- Oysters supplied regularly by fish venders to the majority of restaurants in Goa (70%) as oyster meat while rest of them purchase shell-on oysters. About 25 oyster products are prepared and served in the restaurants and among these, oyster sizzlers, baked oyster, oyster peri peri, oyster masala, oyster sweet and sour, and Goan oyster curry were the most preferred items.
- Survey on awareness of the oyster farmers regarding the depuration techniques, seed production methods, HACCP in post-harvest processing and the methods of value addition of oyster meat has shown that, 65% of the farmers in Ernakulam district have heard about depuration and 10% knew about value added product development. While, at Alapuzha, farmers were not aware about any of these facts and the level of awareness at Kollam was also low.
- The major problem of the oyster farmers was difficulty in removing the oyster meat from the shell. The heat shucking expenses were reported to be high, which formed 10 to 17% of the total income. At Kollam, 70% of the farmers were of the opinion that 16-17% of the income goes as expense for heat shucking.

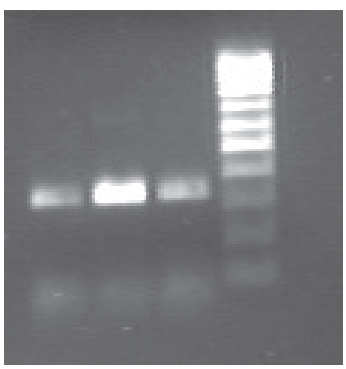
Value added products prepared from oysters
(Frozen oyster curry, oyster soup, battered and breaded oyster, oyster pickle and oyster curry with vegetables)

Outreach Projects

FUNDING AGENCY	**Indian Council of Agricultural Research (ICAR)**
PROJECT TITLE	**ICAR outreach activity on fish genetic stocks**
SCIENTISTS	**P.C. Thomas,** K.K. Vijayan, V. Kripa and Srinivasa Raghavan
CENTRE	Kochi



Lanes 1-7: PCR product of primer cyt1; lane 9: marker



Lanes1-3: PCR product of primer cyt2; lane 4: 100bp marker

Biological characterization

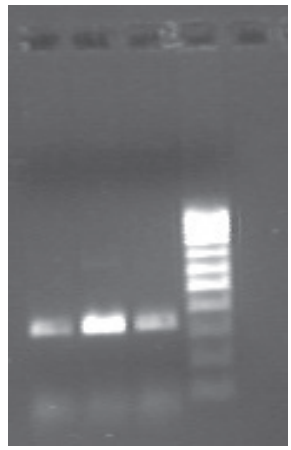
- Morphometric measurements of *Crassostrea madrasensis* samples collected from Kollam, Tuticorin and Veppalodai, and *Pinctada fucata* samples from Kollam and Tuticorin were recorded.
- The morphometric parameters such as anterio-posterial length, dorso-ventral measurement, depth, total weight, meat weight, dry weight, shell weight, shell volume and cavity volume were measured from both species. In addition to this, the left and right valve adductor length and width of the *C. madrasensis* and hinge length as well as left and right valve length of nacreous layer and non-nacreous layer of the *P. fucata* were also recorded. The condition index was estimated for each of the individual animal of both the species. The mean values of the above morphological descriptions are presented.

Mean values of morphometric measurements in *C. madrasensis* from different habitats

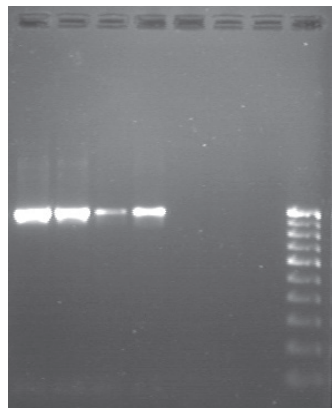
Morphometric trait	Sampling locations		
	Kollam	Tuticorin	Veppalodai
Anterio-posterior measurement (mm)	80.34±14.92	56.47±7.99	88.75±17.96
Dorso-ventral measurement (mm)	57.11±5.29	84.10±25.63	54.77±6.15
Depth (mm)	25.39±3.8	34.092±11.02	28.8±5.42
Total weight (g)	76.78±21.39	108.11±54.05	104.57±37.21
Meat weight (g)	5.44±1.32	5.55±2.28	3.73±1.27
Shell weight (g)	60.55±18.37	88.11±44.53	NR
Left valve adductor length (mm)	18.29±4.35	16.23±3.36	15.59±2.37
Left valve adductor width (mm)	12.07±1.93	10.31±2.12	11.66±2.17
Right valve adductor length (mm)	20.48±2.77	17.52±2.65	15.94±2.62
Right valve adductor width (mm)	13.5±1.95	11.65±2.12	11.46±2.19
Total cavity volume (ml)	39.6±15.26	64.88±34.06	NR
Shell volume (ml)	30.9±10.91	41.55±24.09	NR
Dry weight (g)	1.05±0.29	0.86±0.36	0.87±0.32
Condition Index	117.18±56.88	49.96±38.14	49.39±21.57

Mean values of the morphometric measurements in *P. fucata* from different habitats

Morphometric trait	Sampling locations	
	Kollam	Tuticorin
Hinge length (mm)	41.54±7.55	46.62±7.18
Dorso ventral measurement (mm)	51.53±2.43	59.56±8
Depth (mm)	23.25±9.04	22.39±3.17
Total weight (g)	25.99±4.44	27.44±9.18
Meat weight (g)	7.49±1.5	8.55±1.87
Shell weight (g)	15.01±3.38	16.33±6.20
Dry weight (g)	NR	1.13±0.29
Shell volume (ml)	NR	8.77±1.74
Total cavity volume (ml)	NR	19.11±7.49
Left valve length of nacreous layer 1 (mm)	42.27±4.73	45.27±7.38
Left valve length of nacreous layer 2 (mm)	41.17±2.47	47.37±5.07
Left valve length of nacreous layer 3 (mm)	38.48±2.93	42.28±6.17
Left valve length of non-nacreous layer 1 (mm)	6.62±1.43	3.71±1.22
Left valve length of non-nacreous layer 2 (mm)	7.98±1.53	9.33±2.35
Left valve length of non-nacreous layer 3 (mm)	5.87±1.18	7.93±1.29
Right valve length of nacreous layer 1 (mm)	40.10±2.94	44.95±7.37
Right valve length of nacreous layer 2 (mm)	38.58±2.27	44.27±3.82
Right valve length of nacreous layer 3 (mm)	35.78±1.88	39.67±6.70
Rightvalve length of non-nacreous layer 1 (mm)	7.08±1.28	2.80±0.55
Right valve length of nacreous layer 2 (mm)	10.16±1.49	11.92±2.64
Right valve length of nacreous layer 3 (mm)	11.66±2.39	10.14±2.15
condition Index	NR	173.64±163.82



Lanes 1-4: PCR product of primer Ct; lane 8: 100bp marker



Lanes 1-4: PCR product of primer Ct; lane 8: 100bp marker

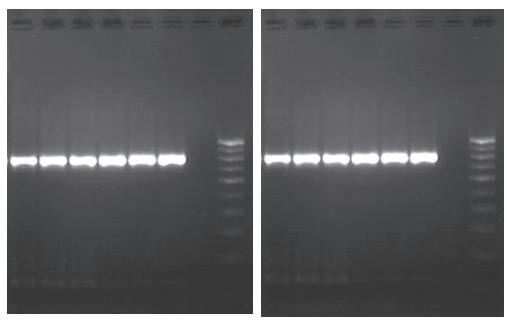
Molecular characterization

- Molecular characterization was carried out using mitochondrial markers and microsatellite markers, for which DNA was extracted from the adductor muscle of *C. madrasensis* and *P. fucata* individuals collected from different natural habitats.

Cytochrome B

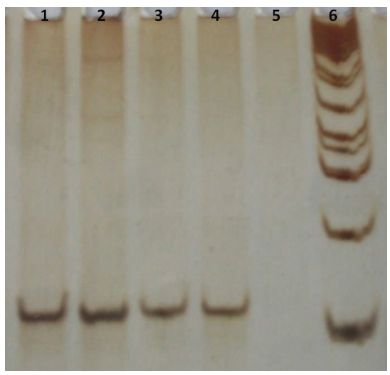
- PCR trials with different sets of primers for Cytochrome b finally resulted in the production of amplicons from *C. madrasensis* by two sets of primers designed based on the sequence information from *C. hongkongensis.*

Code	Primer sequence 52 –32	Tm (°C)
Cyt 1 F	AACAATAAACTGCACCGCAGATG	53.4
Cyt 1 R	GAGGGATGGATCGCAGAATAG	54.8
Cyt 2 F	TAA ACT ACA GCG CAG ATG AG	57.9
Cyt 2 R	TCT GGC TTA ATA ACA GCA GGT G	62.9



Lanes 1-6: PCR product of primer Mj; lane 8: 100bp marker.

- While Cyt1 produced amplicons with 650 bp and 550 bp, Cyt2 produced a 550 bp fragment. Sequencing followed by BLAST search revealed that Cyt2 product only had homology with the cytochrome b sequence of related species.



Microsatellite loci amplified by the primer ucdCg-130 in *C. madrasensis*; Lane 1: Kollam, Lane 2: Sathar Island, Lane 3: Calicut, Lane 4: Kasaragod, Lane 5: Blank, Lane 6: 100bp DNA ladder

Control region

- Two sets of primers synthesized using the sequence information from *Crassostrea gigas* amplified the control region of *C. madrasensis*. The amplicons by Ct and Mj were of 1 kb and 850 bp respectively

Code	Primer sequence 52 –32	Tm (°C)
Ct F	TCACA AGTAC ATTTG TCTTCCA	59.6
Ct R	AACGT TGTAA GCGTC ATGTAAT	60
Mj F	GCCCA AGAAA TTGGC CTTTA	64.7
Mj R	TGCCT TAAGC TTGGG CTACT	62.7

ATPase

- Attempts to amplify ATPase using different sets of primers were not successful in both *C. madrasensis* and *P. fucata*. Hence new primers have been designed based on the conserved regions of ATPase among *Crassostrea* sp. and are under trial for evaluation of amplification efficiency.

Microsatellite marker development in edible and pearl oysters

- Inorder to develop potential microsatellite primers for *C. madrasensis* and *P. fucata*, cross species amplification of microsatellite loci using the primers from closely related species were tried with the candidate species. Microsatellite primers from *Crassostrea gigas* were tried with *C. madrasensis* and microsatellite primers from *Pinctada margaritifera* and *P. maxima* were tried with *P. fucata*.

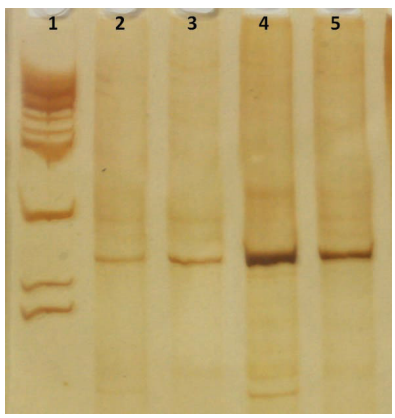
Microsatellite primers of related species identified for cross amplification

- A total of 56 primers (28 pair) were custom synthesized for the cross species amplification of *C. madrasensis* and *P. fucata*. *C. madrasensis* samples were screened for amplification using the 12 primer pairs and out of them only 6 pairs produced amplified products of the expected size.

- The primer ucd CG-130 from *C. gigas*, which was tried in PCR with *C. madrasensis* samples, produced an amplicon of size ~120bp.

- The primer ucd CG-172 from *C. gigas*, which was tried in PCR with *C. madrasensis* samples, produced an amplicon of size ~250bp.

- PCR amplification of *P. fucata* samples are being attempted using the primers from related pearl oyster species to shortlist suitable primers. Mass screening of candidate species collected from different natural habitats shall be carried out with these microsatellite primers for automated genotyping and population structure analysis.



Microsatellite loci amplified by ucdCg-172 in *C. madrasensis* ;
Lane 1: 100bp DNA ladder,
Lane 2: Kollam , Lane 3: Sathar Island ,
Lane 4: Calicut ,

FUNDING AGENCY	**Indian Council of Agricultural Research (ICAR)**
PROJECT TITLE	**ICAR outreach activity on fish feeds**
SCIENTISTS	**P. Vijayagopal,** K.K. Vijayan, Kajal Chakraborty, Boby Ignatius and M.K. Anil
CENTRES	Kochi and Vizhinjam

Fatty acid profiles of phytoplankton and rotifers fed on phytoplankton

- Cultures of marine phytoplankton *Nannochloropsis oculata, Isochrysis galbana*, *Pavlova viridis* and *Dicrateria inornata* developed at a density of 1.2 x 10^6 cell ml^{-1} at a salinity of 30± 5 ‰, temperature 28°C±1°C and pH between 7.8 - 8.1. Differences in fatty acid profiles were looked into and compared with rotifers grown on Baker's yeast *S. cerevisiae*, *N. oculata, I. galbana, P. viridis* and *D. inornata* as given below.

Fatty acid composition of rotifers grown on bakers yeast and microalgae (% fatty acids)

Fatty acids	*S. cerevisiae*	*N. oculata*	*I. galbana*	*P. viridis*	*D. inornata*
14:00	4.91	5.19	6.35	11.25	1.35
15:00	0.84	1.07	0.81	0.86	0.59
16:00	23.48	21.59	14.5	19.37	18.91
18:00	3.63	8.76	5.93	1.92	0.1
24:00:00	0.36	0.54	0.64	1.15	0.75
ΣSFA	**33.22**	**37.15**	**28.23**	**34.55**	**21.7**
16:01	15.06	16.88	3.59	27.9	0.64
18:01	25.09	19.5	20.25	7.41	25.37
24:01:00	0.88	1.23	0.28	0.86	0.34
ΣMUFA	**41.03**	**37.61**	**24.12**	**36.17**	**26.35**
Cis-18:2n6	12.4	4.63	8.48	3.48	6.3
Cis-18:3n6	0.64	0.35	0.15	1.05	0.39
18:3n3	3.59	0.67	5.78	1.47	12.84
18:4n3	0.36	0.15	15.32	2.9	8.65
C20:2n6	0.85	0.82	0.08	0.24	0.19
C20:3n6	0.21	0.54	0.19	0.18	1.06
C20:4n6	0.57	2.15	0.48	1.35	0.98
20:5n3	0.33	9.69	2.6	9.54	6.82
22:5n3	0	0.13	0.44	0.16	0.38
22:6n3	0.09	0.64	9.75	1.81	1.26
ΣPUFA	**19.04**	**19.77**	**43.27**	**22.18**	**38.87**

- Except *I. galbana* all other phytoplantkton were found to be deficient in DHA and EPA. In *I. galbana* 9.75 % of the total fatty acids is DHA.
- Subsequently, rotifers grown on *N. oculata* and *I. galbana* were sampled at intervals and were profiled for their fatty acid composition to ascertain the level of enrichment and time taken to attain the maximum level of enrichment.
- The nutritional enrichment experiments with rotifers were conducted in duplicate at a final volume of 10 l. The main cultures of the rotifers were maintained and fed with *S. cerevisiae* and were constantly checked for water quality.
- The rotifers were kept starved for 18 h prior to initial sampling. Initial mean rotifer density at the start of the 10 L culture was 5 ×10^4 cells l^{-1}. Biomass was harvested at 0, 3, 6, 12, 18, 24, 30, 36 and 48 h in every replicate from the start of experiment.

- Initial microalgal cell densities inoculated were 1.2 x 10^6 cells l^{-1}. Biomass from each replicate was harvested by filtration with 20 µ filters. Samples for biochemical analysis were washed with double distilled water to remove salts, and stored at -20 °C until analysis.
- From these experiments it could be deduced that, for achieving maximum DHA enrichment with *I. galbana*, 12 hours are required and the level of enrichment is sustainable up to 30 hours after which there is a decline when feeding is stopped.
- No improvement in the fatty acid profile could be observed when the rotifers are fed *N. oculata*.

Fatty acid composition of rotifers fed with microalgae (% total fatty acids)

Fatty acids	3 h	6 h	12 h	30 h	48 h
N. oculata					
14:0	8.08	9.29	10.41	12.8	16.11
15:0	0.73	0.79	0.85	1.62	2.15
16:0	21.53	22.05	22.43	25.67	28.14
18:0	4.18	4.26	4.5	6.32	7.45
24:0	0.21	0.28	0.39	0.87	0.86
ΣSFA	34.73	36.67	38.58	47.28	54.71
16:1	14.52	13.69	10.25	10.03	9.37
18:1	24.86	23.14	18.08	19.37	16.75
24:1	1.13	1.58	2.16	2.37	2.91
ΣMUFA	40.51	38.41	30.49	31.77	29.03
Cis-18:2n6	11.57	11.39	14.58	12.06	7.26
Cis-18:3n6	0.58	0.62	0.66	0.68	0.38
18:3n3	3.05	2.62	3.48	1.03	1.24
18:4n3	0.38	0.42	0.58	0.58	0.43
C20:2n6	0.82	1.28	1.26	0.64	0.31
C20:3n6	0.18	0.2	0.28	0.31	0.13
C20:4n6	0.52	0.56	0.84	0.91	0.82
20:5n3	0.97	1.28	2.51	2.58	2.63
22:5n3	0.00	0.06	0.09	0.11	0.12
22:6n3	0.12	0.11	0.15	0.15	0.05
ΣPUFA	18.19	18.54	24.43	19.05	13.37
I. galbana					
14:0	6.39	6.62	6.94	11.09	15.34
15:0	0.93	0.98	1.06	2.39	2.76
16:0	23.02	22.18	23.52	25.71	27.86
18:0	3.15	3.82	3.95	5.36	7.49
24:0	0.19	0.21	0.32	0.5	1.24
ΣSFA	33.68	33.81	35.79	45.05	54.69
16:1	14.85	14.06	13.53	11.48	9.17
18:1	24.17	23.52	22.25	17.06	16.94
24:1	0.91	1.06	1.85	2.11	3.28
ΣMUFA	39.93	38.64	37.63	30.65	29.39
Cis-18:2n6	12.09	11.45	9.2	8.16	7.14
Cis-18:3n6	0.61	0.72	0.75	0.54	0.32
18:3n3	3.78	3.85	4.27	3.04	1.85
18:4n3	0.46	0.51	0.75	0.89	0.62
C20:2n6	1.36	1.38	1.65	1.72	0.78
C20:3n6	0.26	0.39	0.63	0.65	0.2
C20:4n6	0.37	0.42	0.45	0.28	0.19
20:5n3	0.38	0.59	1.64	1.75	1.93
22:5n3	0	0.09	0.13	0.15	0.09
22:6n3	0.23	0.39	0.92	1.13	0.51
ΣPUFA	19.54	19.79	20.39	18.31	13.63

Development of live feed enrichment emulsions and their evaluation

- Sardine oil enriched through biochemical and microbiological procedures were used to formulate enrichment emulsions which contained grossly, 90% fish oil and 10% lecithin extracted from seer fish roe.
- Other than the stability and emulsification ability imparted by lecithin, tocopherol acetate (Vitamin E) at 0.5% was also included as a stabilizer. Two types of emulsions have been developed – EPA rich and DHA rich. Their fatty acid profiles are shown below.

Fatty acid composition of EPA rich and DHA rich oil emulsions (% total fatty acids)

Fatty acids	EPA rich	DHA rich
12:0	0.05	0.03
14:0	0.10	0.02
16:0	0.29	0.13
18:0	0.06	0.04
ΣSFA	**0.50**	**0.22**
16:1n7	11.35	3.19
18:1n9	1.25	4.25
17:1	0.17	0.12
20:1	0.09	0.10
ΣMUFA	**12.86**	**7.66**
18:2n6	2.23	6.58
18:3n3	8.83	11.40
18:4n3	1.29	3.19
C20:4n6	0.13	4.11
20:5n3 EPA	47.78	18.96
22:5n3 DPA	2.90	4.63
22:6n3 DHA	17.11	38.65
ΣPUFA	**79.77**	**87.52**

- DHA rich emulsions were used to enrich rotifers starved for 12 h at 1 ml l^{-1} seawater. Rotifer counts developed up to 10^5 l^{-1} were used to ascertain the following.
  - Size of the oil globules after emulsion
  - Whether the oil globules are consumed by the rotifers
  - The duration of enrichment giving the best profile
  - Whether the clown fish larvae are able to consume the enriched rotifers
- After confirming that the emulsions developed were consumed by rotifers, the duration of enrichment at which the DHA and EPA levels peak was recorded in two experiments and the data is presented.
- DHA rich emulsion peaked in 6 h and EPA rich emulsion peaked in 9 h. Therefore 6-8 h can be taken as the duration of enrichment of rotifers using these emulsions.

Oil emulsion in rotifer, 2 h post-enrichment

Total fatty acids (%) of rotifers enriched with DHA rich oil emulsion

Fatty acids	3 h	6 h	9 h	21 h	24 h
14:0	3.98	3.20	4.50	5.60	5.82
15:0	1.38	0.43	3.20	3.69	4.11
16:0	18.96	16.42	22.04	22.24	25.09
18:0	9.64	6.18	7.12	7.50	8.10
24:0	0.92	0.69	2.11	2.23	1.89
ΣSFA	**34.88**	**26.93**	**38.97**	**41.26**	**45.01**
16:1	2.91	2.54	5.27	5.78	4.05
18:1	14.85	21.11	24.41	30.54	30.58
24:1	4.75	2.87	1.13	1.39	1.47
ΣMUFA	**22.50**	**26.53**	**30.80**	**37.71**	**36.10**
Cis-18:2n6	9.45	6.96	4.32	1.16	1.20
Cis-18:3n6	2.45	0.59	2.22	4.81	3.15
18:3n3	6.12	5.00	2.54	1.53	1.06
18:4n3	1.38	1.69	0.73	0.32	0.19
C20:2n6	0.46	0.17	1.31	2.45	2.34
C20:3n6	1.53	1.69	1.74	1.67	0.98
C20:4n6	6.12	9.84	8.93	4.53	4.28
20:5n3	2.57	2.35	2.07	1.48	1.20
22:5n3	1.53	3.17	0.47	0.51	0.23
22:6n3	4.29	8.76	1.43	1.23	1.14
ΣPUFA	**35.90**	**40.21**	**25.76**	**19.70**	**15.77**

Total fatty acids (%) of rotifers enriched with EPA rich oil emulsion

Fatty acids	3 h	6 h	9 h	12 h	18 h
14:0	4.85	3.22	3.59	6.18	7.24
15:0	0.93	1.54	1.44	0.64	0.72
16:0	24.07	25.99	26.27	30.80	31.49
18:0	6.34	9.08	7.35	7.79	8.25
24:0	0.52	0.91	0.38	0.37	0.55
ΣSFA	**36.71**	**40.75**	**39.04**	**45.78**	**48.25**
16:1	13.21	5.50	5.42	3.92	3.55
18:1	24.11	24.06	22.89	18.07	21.04
24:1	0.92	1.44	0.67	2.45	3.62
ΣMUFA	**38.24**	**31.00**	**28.98**	**24.44**	**28.22**
Cis-18:2n6	8.94	4.68	3.83	2.57	1.28
Cis-18:3n6	1.19	1.37	1.69	0.88	0.69
18:3n3	2.77	1.59	1.25	1.28	2.31
18:4n3	0.25	0.14	0.58	1.72	0.69
C20:2n6	0.77	0.62	0.59	0.51	0.41
C20:3n6	0.86	1.52	1.16	2.06	2.04
C20:4n6	1.94	2.31	3.10	3.82	4.11
20:5n3	1.39	2.97	3.54	4.19	1.07
22:5n3	0.75	1.75	2.94	1.78	1.83
22:6n3	0.93	1.85	3.72	2.65	1.21
ΣPUFA	**19.79**	**18.80**	**22.39**	**21.46**	**15.65**

FUNDING AGENCY	**Indian Council of Agricultural Research (ICAR)**
PROJECT TITLE	**ICAR outreach activity on nutrient profiling evaluation of fish as a dietary component**
SCIENTISTS	**Kajal Chakraborty,** P. Vijayagopal, K.K. Vijayan and I. Rajendran
CENTRES	Kochi and Mandapam

Health survey

- Survey on the assessment of edible fishes and their consumption rate and pattern by different sections of fish eating population in two different regions revealed the health status of the people in the following manner.
- In Kerala, non-fisherman community is more affected with vision problems, asthma and cardiac diseases than fisherman community. In non-fisherman community, aged people were also more prone to diseases.
- Surveys in different islands of Lakshadweep have been completed and the results analyzed. The islands are Agatti, Androth, and Kadamath. The surveys were conducted for 200 each of fishing and non-fishing families, in each site. The people with medium income among fisherman community consume deep sea and coastal tuna. Low income group of fisherman community consume more of low value fishes.

Nutritional composition analyses for candidate fish species collected in different seasons and different locations (east and west coasts of India):

- Different fishes *viz. Lepturacanthus savala*, *Trichiurus lepturus*, *Katsuwonus pelamis*, *Leiognathus splendens* and *Sardinella longiceps* have been collected during different months and locations to understand the influence of spatial and temporal variation on the nutritional components of candidate fish species.

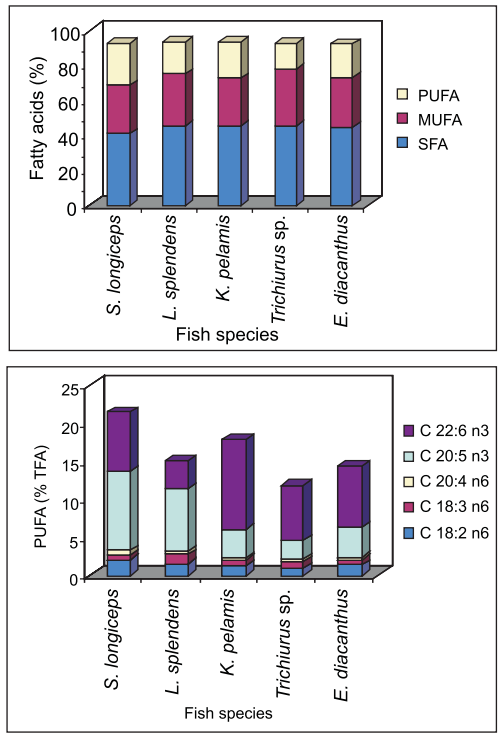
Fatty acid composition of the candidate marine fishes

Kerala

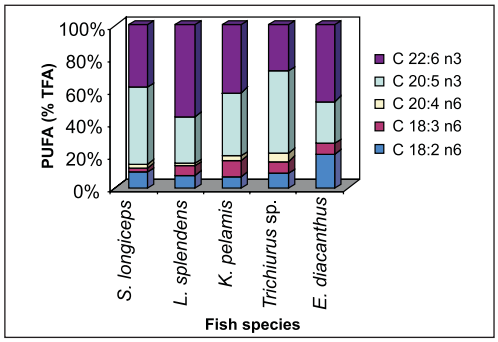
- PUFAs recorded to be more in March-April in oil sardines collected from south-western coast of India. A gradual increase of n-3 PUFA was recorded from November to March, and thereafter decreased up to July. The n-6 fatty acids recorded a dip in November - March and thereafter increased from May to July in *S. longiceps*.
- No significant variation in MUFA was apparent in these species. The n-3/n-6 fatty ratio of all candidate fishes were found to be >2.5, and therefore are very good candidate species.

Mandapam

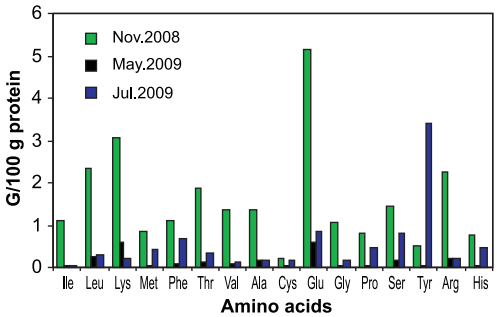
- Total PUFAs were recorded to be higher in *S. longiceps*, *S. albella* and *L. splendens*. However the total SFAs highest in *E. diacanthus*. EPA (C20:5n3) was highest in *Trichiurus* sp. followed by *S. longiceps*. The total n-6 fatty acids of all candidate fishes were found to be very less, and therefore qualify as ideal fish candidates.
- Among essential amino acids, lysine is the major amino acid in all the candidate species. Samples from south-east (SE) coast recorded lower nutritional properties with respect to amino acid content than collected from South-west (SW). In general, the samples in winter



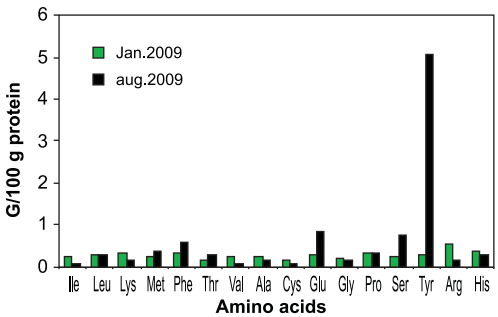
Fatty acid composition of fishes from south-west coast of India



Fatty acid composition of fishes from south-east coast of India



Amino acid composition of *S. longiceps* from SW coast of India



Amino acid composition of *S. longiceps* from SE coast of India

have higher nutritional properties with respect to amino acid balance than collected in summer. Significantly, the amino acid tyrosine was recorded to be significantly higher in *T. lepturus* samples collected from SE coast of India

- Edible oysters have comparatively lower content of the essential amino acids than mussel. Samples in winter have higher nutritional properties with respect to amino acid balance than collected in summer.

Vitamin composition of candidate finfish species

- No significant variation was observed in vitamin E among the samples collected from different parts of SW zone. Samples of *K. pelamis* in May recorded the highest vitamin C. *S. longiceps* and *L. splendens* recorded higher vitamin D contents than in other species. An increase in vitamin C and D content from May to July was recorded in *K. pelamis* (16 IU).

Mineral composition analyses of selected marine fishes

- Samples of skipjack tuna, and oil sardine registered higher Fe content (>4%) than in others. Mg was found to be more in fish samples from SE than from SW coast. Oil sardine and ribbon fish collected from SW in July had more Na than others. Oil sardine was found to possess an optimum combination of all the micronutrients. *L. splendens* was found to be a very good source of Ca and Fe.
- *K. pelamis* collected from SW have more Se (0.148 mg/100 g). However, Se was recorded to be more in winter than in summer. Mg was found to be more in *S. longiceps* samples from SE than SW coast. Oil sardine from SW in November and from SE recorded more Mn than other species. *Leiognathus* from SE and sardine from SW (November) had more K. *Leiognathus* samples collected from SE had more Fe (January) than those collected from SW or in other seasons.

Proximate composition analyses of the candidate fishes and bivalves

- Crude protein (CP) was found to be highest in tuna (25%), and lowest in *Leiognathus splendens*. Groupers had 18% CP. Oil sardines collected in January had lower CP (14%) than December (16%), possibly due to temperature factor and food availability. Crude fat (CF) and nitrogen free extract (NFE) showed only slight variation in all species. However, oil sardine and ribbon fishes had higher CF (14-17%) than others. *P. viridis* had higher crude ash (CA) than *P. indica.*
- In general, crude fat was found to be less in the species collected from south-eastern coast of India than from western coast. It is significant that *P. viridis* from southern Kerala had lower CA than from northern part. NFE was higher in mussels collected from northern Kerala than from southern. NFE was more in edible oyster (wild and cultured) collected from Cochin at different seasons than bivalve mussels. Oil sardine and ribbon fishes had higher CF (13-15%) than others. Fishes collected from Kerala recorded higher CP than from SE coast. Skipjack tuna and groupers registered higher CP (19-20%) than others. Ribbonfishes recorded lowest CP (15.09%). Only a slight variation in crude fiber and nitrogen free extract was recorded among the four candidate fish species. Crude ash was found to be higher in *E. diacanthus* collected during July-December from Kerala.

Patents and Intellectual Property Management and Technology Transfer/Commercialization Unit (ITMU)

- Among the seven forms of IPR as detailed in ICAR Guidelines for Intellectual Property Management and Technology Transfer/Commercialization (ICAR, 2006), the "Patent" (The Patents Act, 1970 as amended in 2006; Rules 2005) is being pursued by CMFRI to protect the existing techniques and technologies developed. The patents are filed through ITMC (Institute Technology Management Committee) and ITMU (Intellectual Property Management and Technology Transfer/Commercialization Unit). Based on recommendations of ITMC, the ITMU pursues the matter for further action and submit to regional patent offices. The unit also puts in effort to create awareness on IP issues and commercialization of viable technologies produced by the Institute.

The following patents have been submitted in the patent offices (Delhi/Chennai): complete/provisional application and/or request for examination

- A device for breeding and culturing marine fish in open sea by Dr. G. Syda Rao *et al.* 31/CHE/2010 (G 424) (Submitted in Chennai Patent Office in 2010).
- A method and composition for land-based culturing of pearl oyster in a marine body and device therefore by Dr. G. Syda Rao (Application No. 1543/CHE/2009 dated 01/07/2009) (Submitted in Chennai Patent Office in 2009).
- Hatchery technology for production of damselfish (Provisional Application No. 1638/DEL/04 dated 31-8-04) by Dr. G. Gopakumar (submitted for examination in New Delhi Patent Office in 2009).
- *In vitro* pearl production using marine organisms (PCT/IB2006/003299 dated 02-02-06) by Dr. Dharmaraj and C.P. Suja (submitted for examination in three foreign countries in 2009).
- Formulated feed for marine ornamental fishes and a process therefore by Dr. P. Vijayagopal *et al.* (Patent submitted in Chennai Patent office in 2010, 31/CHE/2010).
- Confirmation has been received from Delhi Patent Office regarding complete patent application of the patent entitled “Onshore marine pearl culture”, Complete Appl. No. 458/DEL/2001 dt. 26-2-02 by Dr. G. Syda Rao for favour of Indian patent.
- A product containing anti-inflammatory principles from Indian green mussel *Perna viridis*, and a process thereof” by Drs. K. Chakraborty, K.K. Vijayan, P. Vijayagopal, G. Syda Rao, Deepu Joseph, Selsa J. Chakkalakal (submitted to Chennai patent office in 2010).
- A process to prepare naturalised *Artemia franciscana* from Indian subcontinent with high docosahexaenoic acid and trehalose for aquaculture applications by Dr. P.C. Thomas *et al.* (G476, submitted to Chennai patent office during 2010).

Human Resource Development

Training Programme

Training Course	Period	Nodal Division and Location	No. of Participants	Institute
Orientation Course for Scientists (Probationers)	1- 31 July 2009	HRD Cell CMFRI, Kochi	7	CMFRI
Orientation Course for new Scientists	15 July - 1 Aug. 09	HRD Cell CMFRI, Kochi	2	CMFRI
Marine Ornamental Fish Culture	12 - 21 Oct. 2009	Mariculture Division Mandapam RC	20	NFDB, CMFRI
Marine Pearl Culture	20 - 31 Oct. 2009	Mariculture Division Tuticorin RC	5	CMFRI
Ornamental Fish Culture	3 - 17 Nov. 2009	HRD Cell CMFRI, Kochi	20	MPEDA, CMFRI
Cage Culture of Seabass	14 - 23 Dec. 2009	Mariculture Division Kochi	25	NFDB, CMFRI
Orientation Course for Scientists (Probationers)	3 Dec. 09 9 Jan. 10	HRD Cell CMFRI, Kochi	1	CMFRI
Mud Crab Farming	1 - 11 Jan. 10	KVK, Kochi	13	NFDB, CMFRI
Computer Training	24 Feb. to 22 Mar. 10	HRD Cell CMFRI, Kochi	24	CMFRI
Ornamental Fish Feed Production	24 Feb. 10	MBTD, Kochi	29	CMFRI
Field Experience Training to ARS probationers	2 - 22 Mar. 2010	CMFRI, Kochi	8	NAARM

Training for CMFRI Staff

Subject	Institute	No. of participants	Date
Training on Cyber laws, Information Security and Software Quality Assurance	Indian Institute of Public Administration	1	3-5 Sept. 2009
MDP on Priority Setting, Monitoring and Evaluation for Innovation in Agriculture.	NAARM, Hyderabad.	1	19-23 Oct. 2009.
Creative writing in Agriculture	IIMC, New Delhi.	2	3-7 Nov. 2009
Raja Bhasha Sammelan	Bharatiya Rajabhasha Parishad, Puri	1	9-11 Dec. 2009
National Seminar on Conservation and Sustainability of Coastal Living Resources of India	CIFT, Kochi	12	1-3 Dec. 2009
Fisheries Research Management	CIFE, Mumbai	1	Mar. 22 to 11 Apr. 2010.

Training for Technical staff

Subject	Institute	No. of participants	Date
Training programme on Natural Resources Management and Environment	Indian Institute of Management, Lucknow	3	19 - 23 Oct. 2009.

Training for Administrative staff

Subject	Institute, Place	No. of participants	Date
Training on Handling of CAT cases and Court cases	ISTM, New Delhi	1	10 - 12 Aug. 2009
Training on Administration and Financial Matters	NAARM, Hyderabad	3	10 -11 Sept. 2009
Training on Accrual accounting in Government	NIFM, Faridabad	2	29 - 30 Oct. 2009
Workshop on e-Governance	National Informatics Centre, Kochi	1	26 - 30 Oct. 2009
Training on New Pension Scheme	ISTM, New Delhi	3	18 - 19 Dec. 2009
Training on Values in Administration	ISTM, New Delhi	2	22 - 26 Feb. 2010

Ph. D. Programme

Nine Research Fellows under Cochin University of Science and Technology and 12 Research Fellows under Mangalore University have registered for Ph. D programme during 2009-10 and their research work is in progress.

Programmes Organized

Institute Management Committee

Institute Management Committee meeting was held on 29.03.2010 at CMFRI, Kochi. After the approval of the Minutes of the previous IMC held on 30.3.2009 and review of the action taken on the items considered during the 69th IMC, fresh proposals such as proposal for nomination of members to the Institute Grievance Committee, approval of Annual Plan of 'Works' for the years 2009-10 and 2010-11 under Plan/Non-Plan, re-appropriation of saving under Plan Equipment to Plan Furniture for the procurement of Furniture during 2009-10 and approval of Annual Plan for procurement of equipment for the year 2010-11 under XIth Plan were considered followed by financial review for the year.

Research Advisory Committee

The 14th RAC meeting of CMFRI was held in CMFRI, Kochi on 29th March, 2010. The meeting was chaired by Dr. S.D. Tripathi, former Director of CIFE, Mumbai and Chairman of the Committee. Dr. G. Syda Rao, Director, CMFRI made a comprehensive presentation on the progress made by the Institute during 2009. The Chairman and members commented on the progress and made suggestions for improving the research activities of CMFRI. The following recommendations were made by the RAC:

- CMFRI may take steps with the DAHD&F, Ministry of Agriculture for declaration of marine fish landings data collected by the Institute as the official fisheries statistics of the country.
- CMFRI, in association with CIFT, may take steps to be identified as the Certifying Organisation to ecolabel fishing and fishery products.
- Landings data published by CMFRI should be revised by considering recent nomenclature and newly emerging fish groups in commercial fisheries.
- Research on mangrove afforestation and coral replantation may be initiated.
- Research on seaweed farming may be strengthened.
- Survey may be carried out to identify suitable sites and species for cage farming.
- Expertise may be developed to study diseases in mariculture farms.
- A nursery network may be established for cobia to facilitate supply of seed to cage farms.
- Mass production of newly developed GMe product may be taken up following the norms.
- Genetic profiling of maricultured species should be taken up.
- CMFRI may strive to establish a Gene Bank of its own.
- Total Factor Productivity analysis should be strengthened by following proven methodologies.
- A tie-up with Doordarshan is necessary to disseminate the research findings and create awareness among the stakeholders for biodiversity conservation.
- Brainstorming, workshops and awareness programmes should be conducted regularly for the fishermen and fish farmers.
- As a number of posts are lying vacant under the 'Scientists' category, efforts should be made to fill these vacancies on a priority basis.

Quinquennial Review Team for 2004-2009

The Director General, ICAR constituted a QRT to review the work of CMFRI for the period 2004-2009 under the Chairmanship of Dr. S.A.H. Abidi, former Member, ASRB and Director, CIFE, Mumbai. The other members of the QRT were Prof. V. Ravindranath, Dr. M. Zingde, Dr. S.P. Adhikari, and Dr. M.A. Upare. Dr. E.V. Radhakrishnan, Member Secretary assisted them.

The first meeting of QRT was held at Regional Centre of CMFRI, Mandapam Camp, on 18th April 2009 and then at Cochin from 25th-27th May, 2009. The QRT had discussion with the Director, Heads of Divisions and with all staff members and visited the laboratories, hatchery, museum, library, ATIC and other infrastructural facilities at Institute Headquarters. Subsequently, the QRT visited all the Regional and Research Centres of CMFRI and had discussions with the Scientific, Technical, Administrative and Skilled support staff so that the functioning of the Institute at all levels could be objectively assessed to make the general and specific recommendations. The QRT finalized the report and the recommendations were submitted to the DG, ICAR.

Workshops

- Workshop on "Marine biodiversity" at Calicut RC of CMFRI - August 19, 2009.
- Workshop on 'Application of *Primer* V6 in Biodiversity studies' at CMFRI, Kochi, September 4-18, 2009.
- Workshop on 'Biodiversity and Climate Change' at CMFRI, Kochi - September 15, 2009.
- Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Kerala, Karnataka and Goa at CMFRI, Kochi - November 23 - 25, 2009.
- Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Maharashtra and Gujarat at Mumbai Research Centre of CMFRI, Mumbai - November 30 to December 2, 2009.
- Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of West Bengal, Orissa and Andhra Pradesh at Visakhapatnam Regional Centre of CMFRI, Visakhapatnam - November 30 to December 2, 2009.
- Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Tamil Nadu and Puducherry at Madras Research Centre of CMFRI, Chennai - December 3 - 5, 2009.
- International workshop on Marine Mammal Stranding in collaboration with National Oceanic and Atmospheric Administration (NOAA), USA and sponsored by the Indo-US Science and Technology Forum (IUSSTF), New Delhi at CMFRI, Kochi - January 21 - 23, 2010.
- The second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" at CMFRI, Kochi, at all Regional as well as Research centres and two Field Centres of CMFRI - March 15- 23, 2010.
- Workshop on 'Probable Eco-labeling initiatives by CMFRI in India' under the NAIP project -A value chain on oceanic tuna fisheries in Lakshadweep Sea at CMFRI, Kochi – March 30, 2010.
- NAIP workshop on 'Breeding and seed production of marine finfishes with special reference to cobia' at Mandapam Regional Centre of CMFRI, Mandapam Camp - March 30, 2010.

Seminars

- National Consultation and Brain Storming Session' on the future plans for developing Mandapam Regional Centre, at Mandapam Regional Centre of CMFRI, Mandapam Camp - April 18 -19, 2009.
- Seminar on 'Biodiversity and Invasive Alien Species' organized in connection with the International Biological Diversity Day at CMFRI, Kochi – May 22, 2009
- Seminar on "Sea and its ecology" at Calicut RC of CMFRI - August 15, 2009.

Training Programmes

- One day training on "Uniform mode of collection of data" to the State Fishery Officials at State Institute of Fisheries Technology, Kakinada – May18, 2009.
- Training programme on "Mussel harvest" at Moothakunnam on May12, 2009 and at Chettuva on May 25, 2009.
- Training programme on "Oyster farming"" at Puthenvelikkara and at Kottuvallikad - May 25, 2009.
- Training programme on "Clam biology, clam fishery, depuration, product development and conservation" at Vaikam - May 30, 2009.
- Training programme on "Raft and cage fabrication, mooring and mabe image implantation" at Thankassery - June 22, 2009.
- Awareness programme on sea farming with special emphasis on culture of finfishes and shellfishes in open sea cages at Arokyapuram, Kanyakumari District - August 23, 2009.
- National level training course on 'Marine Ornamental Fish Culture' sponsored by National Fisheries Development Board (NFDB) at Mandapam Regional Centre of CMFRI, Mandapam Camp – October 12- 21, 2009.
- Awareness programme on "Better production practices and hygienic handling of bivalves" organized by Calicut Research Centre of CMFRI in collaboration with MPEDA at Valliyaparamba Panchayat Hall on October 27, 2009 and at Padanna Panchayat Hall - October 28, 2009.

- Training programme on 'Seed production and cage culture of brackish water fin fishes for livelihood support' organized in collaboration with BFFDA, Calicut at Calicut RC of CMFRI – November 2- 4, 2009.
- National training programme on "Cage culture of seabass" sponsored by NFDB organized at CMFRI, Kochi – December 14 - 23, 2009.
- Training on 'Mussel farming' organized by Calicut Research centre of CMFRI in collaboration with ADAK, Kerala at Chemmancherry Panchayat - December 23, 2009.
- Training on 'Marine Pearl Culture' at Kalpeni Island, Lakshadweep – January 2 - 13, 2010.
- Training on 'Mussel farming' for fishermen from Goa brought by the Fisheries Department, Goa at Calicut Research Centre of CMFRI- February 3, 2010.
- Training programme on marine ornamental fish culture for participants from the fishermen community sponsored by the Gulf of Mannar Biosphere Reserve Trust (*GOMBRT),* at Mandapam Regional Centre of CMFRI – February 8 - 17, 2010.
- Training programme on 'Taxonomy of Marine Algae' at CMFRI, Kochi - March 24, 2010.

Meetings

- Review meeting of Cage Culture at the Mangalore Research Centre of CMFRI - August 17, 2009.
- Consortium Advisory Committee meeting and Consortium Review meeting of the NAIP project 'A value chain on oceanic tuna fisheries in Lakshadweep Sea' at CMFRI, Kochi - October 5, 2009.
- Meeting with the Deputy Conservator of Forests and Wildlife, Calicut circle on biodiversity conservation of Kadalundi-Vallikunnu community reserve at Calicut RC of CMFRI – October 29, 2009.
- Second meeting of the XIth IJSC of CMFRI at Karwar Research Centre of CMFRI – November 27, 2009
- Meeting of stakeholders and State Fisheries officials at Mandapam Regional Centre of CMFRI – December 10, 2009.
- Marine fisheries stakeholders meet at Karwar Research Centre of CMFRI - December 21, 2009
- Marine fisheries stakeholders meet on "Fishing ban and its effect on Andhra coast" at Visakhapatnam Regional Centre of CMFRI – December 21, 2009.
- Marine fisheries stakeholders meet for Maharashtra state for monsoon fishing ban and management of marine fisheries in the state at Mumbai Research Centre of CMFRI – December 23, 2009.
- Marine fisheries stake holders meet for the Malabar region to review fishing ban and its impact since the inception of the first ban in the state, at Calicut RC of CMFRI – December 30, 2009.
- Stake holders meeting to review fishing ban, its duration and its impact since the inception of the ban in Tamil Nadu at Madras Research Centre of CMFRI – January 12, 2010.
- Review meeting of MoA cage culture project at CMFRI, Kochi -January 28, 2010
- Marine fisheries stake holders meet to review monsoon fishing ban and management of marine fisheries in the state of Kerala at CMFRI, Kochi - February, 15, 2010.
- Review meeting NFDB Cage culture project at CMFRI, Kochi - March 19, 2010
- CIC meeting and CAC meeting under the NAIP project 'A value chain on oceanic tuna fisheries in Lakshadweep sea' at CMFRI, Kochi - March 23- 24, 2010.

MoA cage culture project - Review meeting

NFDB cage culture project - Review meeting

Participation in Exhibitions

- Calicut RC of CMFRI participated in the "Matsyalankar, 2009" organized by National Aquariculture Society, Calicut and won the first prize for best institutional stall – May 1- 25, 2009.
- Exhibition of 'Matsya Mahotsava' in Karnataka - May 8 - 12, 2009.
- National conference of State Fisheries Ministers at Swastikplaza BBSR, Orissa, organized by CIFA – July 4- 5, 2009.
- India Fish Festival, INFISH 2009 organised by NFDB, at People's Plaza, Hyderabad – July 11-13, 2009.
- Haritholsavam - 2009 organised by Ministry of Agriculture, Govt. of India – August 28- 31, 2009.
- Exhibition in connection with the National Seminar on Conservation and Sustainability of Coastal Living Resources of India at CIFT, Kochi – December 1- 3, 2009.
- Vizhinjam Research centre of CMFRI participated in the Aquashow held at Thiruvananthapuram and bagged first prize for the best stall - December 18- 28, 2009
- 'Polima' organized at Fisheries High School, S. N. Puram, Thrissur – December 20- 23, 2009.
- **'**Brinjal Fest 2009' at Mararikkulam, Kanichukulangara – December 27, 2009 to January 3, 2010.
- Exposition of National Seminar on Integrated Management of Water resources with reference to Biodiversity and Livelihood at R.M.N.H, Bhopal – January 16 - 17, 2010.
- 'Karshikamela' at Thodupuzha - January 18 – 26, 2010.
- Agricultural Technology Exhibition and Kisan Mela organized by IISR, Calicut at KVK Peruvannamuzhy, Calicut – February 8- 12, 2010.
- "ANNAM National Food and Agro Bio-diversity Festival" organised by the Centre for Innovation in Science and Social action, Trivandrum at Calicut – February 11 - 15, 2010.
- International Aqua show at Kaloor, Cochin – February 11 - 16, 2010.
- Exposition during CIFT National Seminar on Remote sensing and Fisheries at Abad Plaza, Kochi – February 15 - 17, 2010.

Library and Documentation

The modernised library of CMFRI facilitates the use of print, electronic and digital library resources in most user friendly manner. During the year, 78 books were purchased. The Institute subscribed 75 journals, including national and international, received 400 titles of journals on exchange/complementary basis and subscribed 42 online journals along with print versions. These are made available in HQ/Regional and Research Centres of CMFRI. Access to 500 international open access journals on marine fisheries is made available through digital library, accessible in the CMFRI website.

Services provided

1. OPAC - Online Public Access Catalogue (OPAC) can be accessed globally from CMFRI website. It allows users to search for the bibliographic records and details of books, journals, current periodicals, reports, proceedings, theses and other publications available in the library.
2. Computerised circulation of books and journals has been introduced to the members of the library, using Barcoded Library Identity Card.
3. Digital Library - CMFRI Digital Library System is a sophisticated CD/DVD mirror server housing all electronic publications and information available in the Library. Digital Library can be accessed from CMFRI website. It provides access to DATABASES, CD-ROMs, ELECTRONIC JOURNALS - subscribed and complementary, holdings of journals, current periodicals, CMFRI Theses and Dissertations and CMFRI publications
4. Online Document Delivery Service (ODDS) - provides the latest information in the field of marine research and fisheries. The ODDS is delivered to all the scientists individually by e-mail.
5. Access to CERA - Consortium of electronic journals: CERA, E-Journal Consortium for e-Resources in Agriculture, the project under NAIP, ICAR is made available. It has free access to 3984 electronic journals on agriculture and allied subjects through the site www.cera.jccc.in. As a consortium member CMFRI has these journals activated to the IP address at CMFRI HQ.
7. Digitized the important and rare publications on Indian Marine Sciences available in CMFRI library.
8. Reference facility to researchers, scholars and students, through a nominal fee.
9. Eprint@CMFRI – digital repository: CMFRI establishes Open Access Institutional Repository: Eprints@CMFRI

CMFRI IR is the digital archive of all scientific publications by the CMFRI Scientists. The IR facilitates browsing by year of publication, author, concerned division, subject category and document type. As this repository is indexed in Google, Oaister, Base, Scientific Commons and Scirus, the CMFRI publications reach the global community. CMFRI IR is now registered with the Registry of Open Access Repository (ROAR) published by University of Southampton, UK.

CMFRI Publications released during 2009-10

1. Indian Journal of Fisheries : Vol. 56 Nos. 1-4, 2009
2. Marine Fisheries Information Service : Nos. 197, 198, 199 and 200
3. Newsletter Nos. 120, 121,122 and 123
4. Special Publication Nos. 99 and 100
5. Annual Report : 2008-09
6. Pamphlet Nos. 11, 12 and 13
7. Marine Mammal Chart

Infrastructure Development

Foundation stone laid for the new building of Mangalore RC of CMFRI

- Foundation stone for the new building of CMFRI, Mangalore was laid on 7th November, 2009 at the Technology wing campus of the Mangalore Fisheries College, by the honourable DG, ICAR, Dr. Mangala Rai. Dr. S. Ayyappan, DDG, Fisheries, Dr. Mohan Joseph Modayil, Member, ASRB, New Delhi and Dr. G. Syda Rao, Director, CMFRI were present on the occasion.

Foundation stone laying of the new building of Mangalore RC of CMFRI

New laboratory for Genetics and Genomics in the Marine Biotechnology Division at CMFRI, Kochi

- A new laboratory for Genetics and Genomics has been developed with sophisticated instruments like Realtime PCR, Gradient PCR, Advanced Gel Documentation system, Electroporator, Biophotometer, Ultrafreezer, Incubator Shaker, Microfuge, Electrophoretic systems and Laminar flow, with the funding support from Department of Biotechnology (DBT) and NAIP.

Biotechnology laboratory at Karwar Research Centre of CMFRI

- The newly developed Biotechnology laboratory was inaugurated at Karwar Research Centre of CMFRI by Dr. G. Syda Rao, Director, CMFRI on 27th November, 2009.

Integrated Marine Floating Cage Farm Developed at Karwar

- An integrated marine cage farm was developed off Karwar for the culture of seabass, red snappers, mullets, groupers and green mussel.

Inauguration of biotechnology laboratory at Karwar RC of CMFRI by Dr. G. Syda Rao, Director, CMFRI

Integrated Marine cage farm of Karwar Research centre of CMFRI

Cost- effective metal cage (6 m dia) developed at Karwar

Designated National Repository

Herbarium

- A Herbarium of seaweeds has been added to the National Designated Repository Museum at the Headquarters of CMFRI. Work has been completed for 85 species of seaweeds from the Gulf of Mannar Biosphere Reserve. Colour preservation of the seaweeds also has been attempted.

New additions to the National Repository

Seaweeds

1. *Chaetomorpha aerea (*Dillw.) Kuetz.
2. *Chaetomorpha linum (*Muller) Kuetz.
3. *Cladophora bombayensis* Boergs.
4. *Caulerpa laetevirens* Mont.
5. *Caulerpa serrulata* (Forssk.)J.Ag.
6. *Boergesenia forbesii* (Harv.) J. Feld
7. *Padina tetrastromatica* Hauck.
8. *Colpomenia sinuosa* Derb
9. *Rosenvingia nhatrangensis* Dawson
10. *Sargassum cristaefolium* C.Ag.
11. *Sargassum polycystum* C.Ag.
12. *Turbinaria decurrens* Bory
13. *Turbinaria ornata* J.Ag.
14. *Liagora doridis* Zeh.
15. *Liagora orientalis* J.Ag.
16. *Amphiroa anceps* (Lam.) Decaisne
17. *Amphiroa foliacea* Lam.
18. *Amphiroa fragilissima* (Linn.)Lam.
19. *Cheilosporum spectabile* Harv.
20. *Grateloupia lithophila* Boergs.
21. *Halymenia dilatata* Zau
22. *Halymenia floresia* (Clem.) C.Ag.
23. *Gracilaria corticata* var. *corticata* J.Ag.
24. *Gracilaria corticata* var. *Pudumadamensis* Krishnamurthy and Rajendran
25. *Gracilaria foliifera* (Forssk.) Boergs.
26. *Gracilariopsis lemaneiformis* (Bory) Dawson, Acleto and Foldvik
27. *Sarconema filiforme* (Sounder)Kylin
28. *Hypnea pannosa* J.Ag.
29. *Botryocladia leptopoda* (J.Ag.)Kylin
30. *Centroceras clavulatum* (C.Ag.) Mont.
31. *Spyridia fusiformis* Boergs.
32. *Acanthophora spicifera* (Vahl.)Boergs.
33. *Laurencia poitei*(Lam.) Howe
34. *Cymodocea rotundata* Ehrnb. & Hempr
35. *Cymodocea serrulata Ascher. & Magnus*
36. *Halodule uninervis* (Forskall) Ascherson
37. *Syringodium isoetifolium* Dandy
38. *Enhalus koenigi* Rich *(=Enhalus acoroides* (Linn.f) Royle)
39. *Halophila ovalis* (R.Br) Hook.f
40. *Halophila ovata* Gaud.
41. *Lyngbya majuscula* C Agardh

Lobster

1. *Enoplometopus occidentalis* Randall,1840

Echinoderms

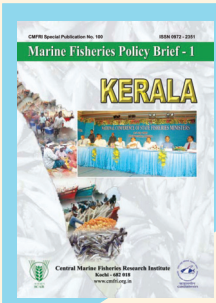
1. *Astropyga radiate* (Leske, 1978)
2. *Protoreaster lincki* (de BlainVille, 1840)
3. *Clypeaster rarispinus* de Mejere, 1902
4. *Laganum depressum* Lesson
5. *Peronella lessueri* (Valenciennes, 1841)
6. *Lovenia elongate* (Gray**)**

Fish

1. *Glaucostegus granulatus* (Cuvier, 1829)
2. *Synodus variegatus* (Lacepède, 1803)
3. *Synodus binotatus* Schultz, 1953
4. *Synodus indicus* (Day, 1873)
5. *Acanthurus gahhm* (Forsskål, 1775)
6. *Epinephelus polyphekadion* (Bleeker, 1849)
7. *Tetrosomus gibbosus* (Linnaeus, 1758)
8. *Abudefduf bengalensis* (Bloch, 1787)
9. *Halichoeres nigrescens* (Bloch & Schneider, 1801)
10. *Setipinna taty* (Valenciennes, 1848)
11. *Caesio cuning* (Bloch, 1791)
12. *Pardachirus pavoninus* (Lacepède, 1802)
13. *Nibea soldado* (Lacepède, 1802)
14. *Plicofollis dussumieri* (Valenciennes, 1840)
15. *Pennahia anea* (Bloch, 1793)
16. *Saurida nebulosa Valeciennes,1850*
17. *Ilisha elongata* (Bennet, 1830)
18. *Gymnothorax punctatus* Bloch & Schneider, 1801
19. *Lutjanus quinquelineatus* (Bloch, 1790)
20. *Lutjanus fulviflamma* (Forsskål, 1775)
21. *Saurida isarankurai* Shindo &Yamada, 1972
22. *Carangoides plagiotaenia* Bleeker, 1857
23. *Lutjanus lemniscatus* (Valenciennes, 1828)
24. *Lutjanus biguttatus* (Valenciennes, 1830)
25. *Decapterus macarellus* (Cuvier, 1833)
26. *Lutjanus madras* (Valenciennes, 1831)
27. *Saurida longimanus* Norman, 1939
28. *Hyporhamphus dussumieri* (Valenciennes, 1847)
29. *Amphiprion ephippium* (Bloch, 1790)
30. *Premnas biaculeatus* (Bloch, 1790)
31. *Diaphus garmani* (Gilbert, 1906)
32. *Symphysanodon typus* Bleeker, 1878
33. *Pseudanthias fasciatus* (Kamohara,1954)
34. *Eleutheronema tetradactylum* (Shaw,1804)
35. *Cephalopholis boenak* (Bloch,1790)

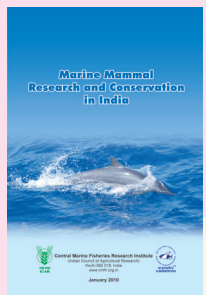
Publications

Fish Farming in Cages (Hindi)
CMFRI Special Publn. No. 99
2009 : 78 pp.



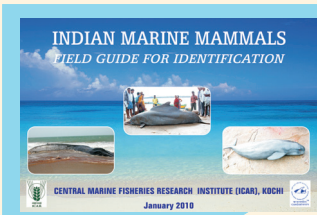
Marine Fisheries
Policy Brief - 1 : Kerala
(English & Malayalam)
CMFRI Special Publn. No. 100
2009 : 48 pp.

Matsyagandha 2009
Vistas in Aquaculture
Biotechnology (Hindi)
CMFRI Special Publn. No. 102
2010 : 69 pp.



Marine Mammal Research and
Conservation in India
(E. Vivekanandan *et al.*)
CMFRI Pamphlet
No. 13/2010 : 20 pp.

Tamil Pamphlet on Cage Culture
(Kadalil mithavai
koondugalil meen valarpu):
CMFRI Pamphlet No.11/2010



Indian Marine Mammals -
Field Guide for Identification :
(E. Vivekanandan *et al.*)
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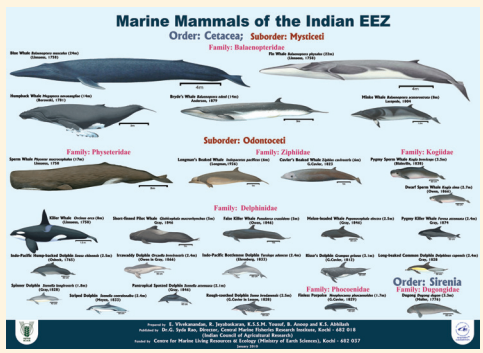

Poster on Marine Mammals of the Indian EEZ

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Video

Trawling for the Future – A Guide to Responsible Fishing A 16 minute video has been produced in 4 languages (English, Gujarati, Hindi and Malayalam). The English version in low resolution format has been uploaded into the youtube website for wider viewing (http://www.youtube.com/watch?v=AUaixPHjpSk and http://www.youtube.com/watch?v=mCyGpsCuMnA

Krishi Vigyan Kendra

During 2009-10, the Krishi Vigyan Kendra, Kochi organized 46 training courses for 1,086 villagers including farmers and rural youth in three disciplines (16 courses in Fisheries for 353 beneficiaries, 14 courses in Agriculture for 298 beneficiaries and 16 courses in Home Science for 435 beneficiaries).

The topics covered under Fisheries included coastal aquaculture, mudcrab farming and ornamental fish culture. Topics under Agriculture included pokkali paddy cultivation, coconut cultivation, organic pesticide preparation for kitchen garden and scaling-up of water productivity in agriculture for enhancing livelihood. Topics under Home Science included value addition of fish/shrimp, value addition of fruits/vegetables, mushroom processing and preparation of household cleaning materials.

On-farm testing (OFT) programmes

- Sea bass fingerlings were cultured in a farmer's pond of 0.08 ha at Cherai in Vypeen Island and was harvested on 12/4/2009.
- Trials of small scale depuration unit for clam meat
- High-density planting of tissue culture banana
- Farm trials of coconut climbing machine
- Cultivation of new Pokkali paddy variety, VTL-7 (KAU).
- Nursery rearing of marine ornamental fishes (from hatchery) as a new source of income
- Nursery rearing of sea bass (from hatchery) as a new source of income
- Adaptability of brush cutter for harvesting paddy
- On-farm production of organic manure in coconut garden

Front line demonstration (FLD) programmes

- Cultivation of proven Pokkali paddy variety, VTL-6 (KAU)
- Cultivation of high yielding cassava varieties : Sree Lekha and Sree Rekha (CTCRI)
- Introduction of euryhaline brackishwater fishes in unutilized freshwater pond systems
- Demonstration of carp farming in unutilized freshwater pond systems
- Scientific management of stem bleeding in coconut using Tridemorph and neem cakes
- Eco-friendly management of fruit fly in cucurbits using pheromone trap
- Demonstration of farming of oyster mushroom, Co (OM) 2 *Hypsizygus ulmarius*
- Demonstration of hand-operated cassava chipping machine
- Demonstration of cassava harvesting tool

Programme participation

Dr. K. Asokakumaran Unnithan

- Meeting of KVKs, ATMA and Line Departments at Kerala Agricultural University (KAU), Thrissur - 8 April 2009.
- Zonal level Annual Action Plan presentation Meeting of KVKs of Kerala at Zonal Project Directorate, Bangalore - 27-28 April, 2009.
- Scientific Advisory Committee Meeting of the KVK of CPCRI (ICAR), Kayamkulam - 6 August, 2009.
- National Conference of KVK at TNAU, Coimbatore - 6-8 November, 2009.
- Zonal Review Meeting of KVK of Zone VIII held at Jagadguru Sri Shivarathreeswara Math, Suttur, Mysore - 7-10 December, 2009.

- Technology Expo-cum-Farmers' Mela, *Krishi Darpan*, organized by the Central Institute of Fisheries Technology, Cochin - 11-12 March, 2010.

Radio programmes

- Dr. K. Asokakumaran Unnithan Participated in a phone-in programme on approaches to agricultural development strategies in the changing scenario conducted by FM Station of All India Radio, Kochi - 15 May 2009.

Participation in exhibitions

- National exhibition organized by the Central Ministry of Agriculture in *Haritotsavam* at Ernakulam - 28-31 August, 2009.
- Exhibition organized by the Department of Industries, Govt. of Kerala and Kerala Agricultural University in connection with Kerala Agri-food Technology Meet at Thrissur - 9-11 October, 2009.
- Exhibition organized by the Arayankavu Branch of the District Co-operative Bank at Arayankavu, Cochin - 25–26 November, 2009
- Brinjal Festival at Mararikulam in Cherthala Taluk, Alleppey District - 27 December, 2009 – 03 January, 2010.
- Exhibition organized at Thanneermukkom Grama Panchayath in Alleppey District as a part of Integrated Matsya Gramam Project - 15-17 January, 2010.
- Exhibition organized in connection *Krishi Darpan*, organized by the Central Institute of Fisheries Technology, Cochin at Ernakulam - 11-12 March, 2010.

Science camp

- Wetland development, focusing on conservation of mangrove systems at KVK - 24 September, 2009.
- Science Camp of 10 working days duration for 27 students and three staff of the Vocational Higher Secondary (Aquaculture) stream of Govt.V.H.S.S, Narakkal - 16-28 November, 2009.

Technology Week celebration

As called upon by Dr. K.D. Kokate, Dy. Director General, Agricultural Extension to celebrate Technology Week in all KVKs in the country aimed at re-orienting KVK as 'Farmer's Stop' for appropriate and effective dissemination of latest technologies to the farmers, the Narakkal KVK organized the Technology Week during 26-30 October, 2009. Exhibition, seminars and demonstration programmes on various topics under Fisheries, Agriculture and Home Science were organized during the campaign with the active partnership of different agencies.

Visitors

- Quinquennial Review Team (QRT) of the Central Institute of Brackishwater Aquaculture, Chennai headed by Dr. T. J. Pandian, Dr. A. G. Ponnaiah, Director, Dr. A. R. T. Arasu and Dr. S. M. Pillai, Principal Scientists - 12 June, 2009.
- Dr. (Mrs.) M.K. Sheela, Director, Extension, Kerala Agricultural University, Shri. A. C. Philip, Joint Director and Principal Agricultural Officer, Ernakulam, Shri. A.V.V. Subramanian, Assistant General Manager, NABARD, Ernakulam, Shri. K.R. Jayaprakash, Lead District Manager, Union Bank, Ernakulam, Shri. D. Subramanian, State Marketing Manager, IFFCO, Dr. (Mrs.) S. Girija, Director, National Institute of Fisheries Post-Harvest Technology and Training Visited during the Technology Week celebrations - 26-30 October, 2009.
- CMFRI Quinquennial Review Team headed by Dr. S.A.H. Abidi - 22 October, 2009
- Dr. K.D. Kokate, Deputy Director General (Agricultural Extension), ICAR, New Delhi accompanied by Dr. S. Prabhukumar, Zonal Project Director, Zone VIII, TOT Projects, ICAR, Bangalore - 11 January, 2010.

Collaborative programmes

- Farmers' training on scaling-up of water productivity in Agriculture for livelihood funded by ICAR under the All India Co-ordinated Research Project at CMFRI, Cochin - 7-15 December 2009.
- Farmers – Scientists Interface Programme organized by the KVK at CMFRI, Cochin. More than 41 farmers and 18 resource persons were involved - 18 – 19 March. 2010

Human Resource Development

Sl. No.	Name of staff	Title of training	Date	Organizing Agency
1	Dr. (Mrs.) K. Smita Sivadasan, SMS (Animal Husbandary)	Integrated farming System for Sustainable Livelihood	February 23-25, 2010	KVK, TANUVAS, Namakkal
		Orientation programme for SMS and Programme Assistants	March 24-27, 2010	KVK, Dakshina Kannada
2	Shri. Vijendra Kumar Meena, SMS, Agronomy	Orientation programme for SMS and Programme Assistants	March 24-27, 2010	KVK, Dakshina Kannada
3	Shri. Shoji Joy Edison, SMS, Horticulture	-do-	-do-	-do-
4	Shri. F. Pushparaj Angelo SMS, Agricultural Extension	-do-	-do-	-do-
5	Dr. S. Shanas, SMS, Plant Protection	-do-	-do-	-do-
6	Miss. N. V. Dipti, Programme Assistant, Laboratory Technology	-do-	-do-	-do-

Scientific Advisory Committee Meeting

The Second Meeting of the re-constituted Scientific Advisory Committee meeting of the Krishi Vigyan Kendra was held on 22 March, 2010 at CMFRI Headquarters, Cochin. On behalf of the Director, CMFRI, Dr. R. Narayana Kumar, Senior Scientist, CMFRI presided over the Meeting.

Members of the SAC representing Zonal Project Directorate, Bangalore, Central Institute of Fisheries Technology, Kerala Agricultural University, Union Bank of India (Lead Bank), All India Radio, Department of Fisheries, District Industries Centre, Department of Animal Husbandry, Vegetable and Fruits Promotion Council, Farmer and Farmwomen representatives, Senior Administrative Officer and Senior Finance and Accounts Officer of CMFRI and staff of the KVK participated in the Meeting.

Major recommendations of the Meeting included

- Experts from all disciplines of agriculture may be invited to the SAC Meeting
- Experts from the Rice Research Station of Kerala Agricultural University, Vyttila may be invited to the Meeting
- Soil-Water-Plant Testing facility may be established and the services may be made available to the farmers at low cost
- Demonstration Units may be established at Thevara campus of CMFRI
- Impact of training and other activities may be studied
- Cultivation of spices and other medicinal plants may be promoted
- Necessary action may be taken to apply for Revolving Fund
- Seed production of the finfish, pearl spot may be promoted.

Official Language Implementation Activities for the year 2008-2009

Ensurance of bilingualisation and targets of correspondence

- During the year, cent per cent bilingual issue of Section 3(3) documents (1,844 nos.), reply of letters received in Hindi (537) and target of Hindi correspondence (80.5% against the target of 55%) were ensured.

Official Language Implementation Committee meeting

- The 78th, 79th and 80th meetings of Official Language Implementation Committee of the Institute were held on 02-05-2009, 24-9-2009 and 22-12-2009 respectively.

Review of OL activities at outstations

- The Official Language implementation activities of all Regional/Research Centres were reviewed and suggestions were given for improvement.

Inspections

- Parliamentary Committee inspection: Second sub-committee of the Parliamentary Committee on Official Language inspected the implementation activities of Veraval Regional Centre of CMFRI on 18-01-2010.
- Inspection of Department of OL: Shri M. Vijayakumar, Assistant Director (Impln.), Hindi Implementation Office (S.W), Dept. of Official Language, Ministry of Home Affairs, Cochin inspected the Official Language Implementation activities of CMFRI Headquarters, Cochin on 27-10-2009.
- Outstation inspections: Director, CMFRI inspected the Official Language implementation activities of Calicut Research Centre on 02-02-2009 and on 01-05-2009, Madras Research Centre on 07-07-2009, Mangalore Research Centre on 17-08-2009 and Veraval Regional Centre on 19-01-2010 .

HRD programme

- Hindi workshops: Three Hindi workshops were conducted at Headquarters, Cochin on 26 and 27 March, 2009, 25 and 26 June, 2009 and 24-09-2009, three at Veraval Regional Centre on 24-03-2009 and 05-06-2009, 16-12-2009, three at Bombay Research Centre on 17-06-2009, 31-08-2009 and 24-09-2009, One each at Calicut Research Centre on 29-06-2009, Tuticorin Research Centre on 26-06-2009 and Visakhapatnam Regional Centre on 31-07-2009. Total 185 officers/ employees were trained during these workshops.
- Correspondence course: Two ministerial staff were deputed for Hindi typewriting correspondence course.
- A word a day: Under *A word a day* programme, 288 Hindi words with English synonyms were displayed in computers and the display board at CMFRI, Kochi.
- Special incentive scheme: Under the special incentive scheme eight officers/staff won cash awards. Special incentive scheme is in effect at Mangalore and Calicut Research Centres and at Veraval Regional Centre.

Hindi Fortnight Celebration

- Hindi Fortnight was observed at CMFRI, Kochi from 14 to 26 September, 2009 with various competitions/programmes. Ms. K. Noorjehan, Hon'ble Member of Central Administrative Tribunal (CAT), Eranakulam Bench was the Chief Guest for the valedictory function. Winners of competitions and overall contributors were felicitated during the function.
- Hindi Day/Week/Fortnight was also observed in all Research/Regional Centres of CMFRI.

National Scientific Seminar

- To disseminate the research achievements of the Institute in Official Language, a two day National Scientific Seminar on ***Fish Farming in Cages*** was organized during 25-26 August, 2009 at CMFRI, Cochin. The Seminar was inaugurated by Dr. P.S. Parameswaran, Scientist-in-Charge, National Institute of Oceanography, Cochin. Twenty four research papers were presented during the Seminar in two sessions. Five Scientists were given best presentation awards. A special publication on ***Fish Farming in Cages*** was released by the Chief Guest on the same day.

Press and editorial work performed

a. Special Publications in Hindi

i) Matsyagandha - 2007

ii) Pinjarom mei machali paalan

b. Annual Report 2008-2009 with Hindi Executive Summary

Release of special publication

Awards

i) **Rajarshi Tandon Award**

- CMFRI has won the Rajarshi Tandon Award of ICAR (2nd position) for Official Language activities during the year 2008. Dr. G. Syda Rao, Director, CMFRI received the award at a function organized in connection with the ICAR Foundation Day on 16th July, 2009.

Dr. G. Syda Rao receiving the Rajarshi Tandon Award from
Hon. Central Minister (New and Renewable Energy)
Dr. Farooq Abdullah

ii) **TOLIC Award**

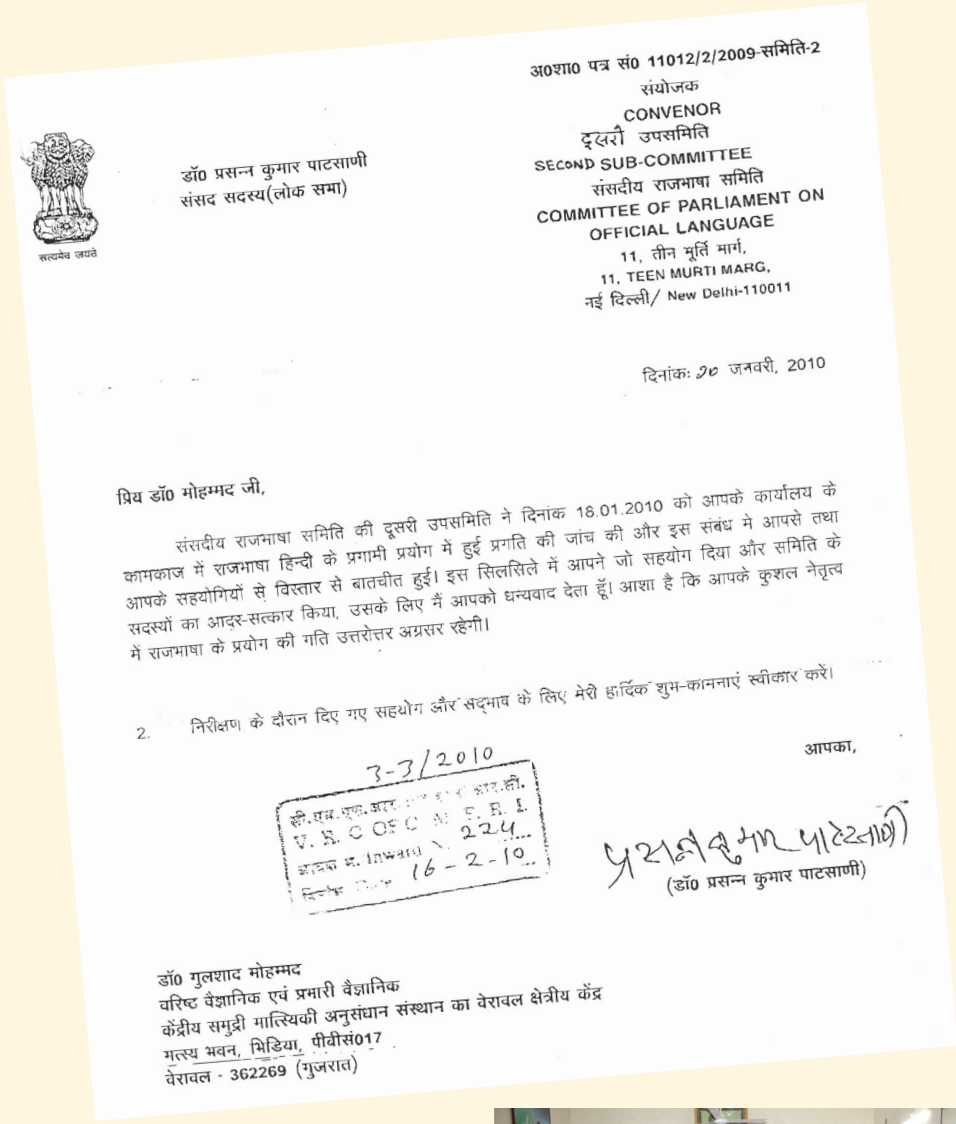
- CMFRI has won the Rajbhasha Rolling Trophy (Ist position) of Kochi Town Official Language Implementation Committee for excellence in the Official Language Implementation during 2008-2009. The Institute also bagged Rolling Trophy (3rd position) for *Matsyagandha*, CMFRI Special Publication in Hindi.

iii) Mangalore Research Centre of CMFRI bagged the Mangalore TOLIC Award (II position) for implementation of Official Language policy during 2008-09.

iv) Karwar Research Centre has won the Rolling Trophy distributed by the Karwar TOLIC for the best performance in implementing the Official Language activities during 2008-09.

Inspection by the Parliament Committee

The Second Sub-Committee of the Committee of Parliament on Official Language inspected the progress made in the use of Official Language at the Veraval Regional Centre of CMFRI on 18th January 2010, expressed satisfaction in the ongoing work and issued a letter of appreciation to the Scientist-in-Charge, Veraval Regional Centre of CMFRI.



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संयोजक
CONVENOR
दूसरी उपसमिति
SECOND SUB-COMMITTEE
संसदीय राजभाषा समिति
COMMITTEE OF PARLIAMENT ON OFFICIAL LANGUAGE
11, तीन मूर्ति मार्ग,
11, TEEN MURTI MARG,
नई दिल्ली/ New Delhi-110011

सत्यमेव जयते

डॉ0 प्रसन्न कुमार पाटसाणी
संसद सदस्य(लोक सभा)

दिनांक: 20 जनवरी, 2010

प्रिय डॉ0 मोहम्मद जी,

संसदीय राजभाषा समिति की दूसरी उपसमिति ने दिनांक 18.01.2010 को आपके कार्यालय के कामकाज में राजभाषा हिन्दी के प्रगामी प्रयोग में हुई प्रगति की जांच की और इस संबंध मे आपसे तथा आपके सहयोगियों से विस्तार से बातचीत हुई। इस सिलसिले में आपने जो सहयोग दिया और समिति के सदस्यों का आदर-सत्कार किया, उसके लिए मैं आपको धन्यवाद देता हूँ। आशा है कि आपके कुशल नेतृत्व में राजभाषा के प्रयोग की गति उत्तरोत्तर अग्रसर रहेगी।

2. निरीक्षण के दौरान दिए गए सहयोग और सद्भाव के लिए मेरी हार्दिक शुभ-कामनाएं स्वीकार करें।

आपका,

(डॉ0 प्रसन्न कुमार पाटसाणी)

3-3-2010
V. R. C. OF C. M. F. R. I.
224
16-2-10

डॉ0 गुलशाद मोहम्मद
वरिष्ठ वैज्ञानिक एवं प्रभारी वैज्ञानिक
केंद्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान का वेरावल क्षेत्रीय केंद्र
मत्स्य भवन, भिडिया, पीवीसं017
वेरावल - 362269 (गुजरात)

Letter of appreciation received from the Convenor of the Parliament Committee

Parliament Committee meting at VRC of CMFRI, Veraval

Participation of Scientists in Conferences/Meetings/Workshops/Symposia and Training in India and Abroad

Dr. G. Syda Rao, Director

Workshop-cum-Brainstorming Meeting on Marine Resource Development and Management at IIT, Kharagpur on 13 April, 2009.

Brain storming (National Consultancy) meeting and preliminary meeting of QRT at Mandapam Regional Centre of CMFRI during 18 - 19 April, 2009; Calicut RC of CMFRI on 1 May, 2009; Mangalore RC of CMFRI on 7 May, 2009 and at Karwar RC of CMFRI during 8-9 May, 2009.

NAIP Sensitization meeting at New Delhi on 5 May, 2009.

Meeting of the working group of Indian Ocean Tuna Commission (IOTC) at New Delhi during 17-20 May, 2009.

International Day on Biodiversity organized jointly by NBPGR Ministry of Environment and Forests, National Biodiversity Authority and ICAR at New Delhi during 17-22 May, 2009.

Meeting with NFDB officials at Hyderabad on 1 June, 2009.

National Conference of State Fisheries Ministers at CIFA, Bhubaneswar during 4-5 July, 2009.

Inaugural Ceremony of ICAR Foundation Day and Directors' conference at ICAR, New Delhi during 16-17 July, 2009.

Open sea cage culture review meeting at Mangalore Research Centre on 17 August, 2009.

Inaugural function of the Haritholsavam 2009 at Maradu on 28 August, 2009.

Inaugural function of the newly constructed building of CMFRI and CIBA at Madras during 2-5 September, 2009.

Meeting in connection with the QRT work at NASC, New Delhi during 20-23 September, 2009.

Chennai Research Centre for review of research and NIOT Lobster Conference function and submission of QRT report at New Delhi during 4-5 January, 2010.

Mumbai Research Centre and Veraval Regional Centre in connection with visit of Parliamentary Committee during 15-20 January 2010.

Cage Culture Review Meeting of DAHD&F- CMFRI at CMFRI, Cochin on 28 January, 2010.

DG's Meeting at New Delhi during 29-30 January, 2010.

Vizhinjam Research Centre of CMFRI to conduct research review meeting with Scientists and to witness the harvest of 1st batch of lobsters from the cage at Kanyakumari during 6-7 February, 2010.

Director's Meeting at New Delhi during 11-17 February, 2010.

State Level Committee for the operation of the project 'Seed production in agricultural crops and fishereis' at CMFRI, Kochi on 20 February, 2010.

Second Meeting of the Technical Committee to assess the Impact of Fishing Ban at CMFRI, Kochi on 20 February, 2010.

Second Meeting of the Expert Committee for revalidation of potential Fishery resources in the Indian EEZ at CMFRI, Cochin on 9 March, 2010.

Inaugural ceremony of ICAR - Zonal Technology Management Centre and Business Planning and Development Unit at CIFT, Cochin on 12 March, 2010

NFDB meeting at Hydrabad during 23-25 March, 2010.

Scientists

April, 2009

Project monitoring and evaluation under the aegis of NAIP conducted at NAARM, Hyderabad on 4 April, 2009 - Dr. J. Jayasankar

National Consultation and Brainstorming Session on Marine Biodiversity Management and Mariculture held at Mandapam Regional Centre of CMFRI during 18-19 April 2009 - Dr. E. Vivekanandan, Dr. E.V. Radhakrishnan and Dr. (Mrs.) Mary K. Manisseri.

QRT meeting at Mandapam RC of CMFRI on 20.4.2009, at CMFRI HQ from 25.5.2009 to 27.5.2009, at Mumbai Research Centre, Veraval Regional Centre, CSMCRI, FSI and Fisheries Department of Gujarat from 29.6.2009 to 3.7.2009, at Calicut, Mangalore and Karwar Research Centres from 14.7.2009 to 17.7.2009, at Visakhapatnam Research Centre from 23.7.2009 to 25.7.2009 and at Madras Research Centre on 27.7.2009. Preparation of final report at CMFRI, Kochi from 21.10.09 to 24.10.2009 - Dr. E.V. Radhakrishnan.

National Workshop on 'Plans and Development of a National Programme for Sustained Indian Ocean Biogeochemical & Ecological Research (SIBER)' at National Institute of Oceanography, Dona Paula, Goa during 13-14 April, 2009 - Dr. E. Vivekanandan and Dr. (Mrs.) Sujitha Thomas.

Evaluation Committee meeting constituted under the Kochi TOLIC for deciding the Rajbhasha Rolling Trophies for the year 2007-08 at Income tax Office, Kochi on 23 April, 2009 - Dr. E.V. Radhakrishnan.

May, 2009

Workshop of the NAIP Component -2 at Tamil Nadu Agricultural University, Coimbatore during 3-4 May 2009 - Dr. V. Kripa

Climate Change and Indian Marine Fisheries in India-Brazil-South Africa workshop at NIO, Goa during 4-8, May, 2009 - Dr. E. Vivekanandan

Conservation of fishery resources and need for responsible fisheries in the Silver Jubilee State level Seminar organized by Matsyafed at Trivandrum on 11 May, 2009 - Dr. N.G.K. Pillai.

Working Group - constituted for monitoring and review of implementation of IOTC resolutions at Krishi Bhavan, New Delhi on 19, May, 2009 - Dr. N.G.K. Pillai

Reconstituted Expert Group-B on Conservation and Sustainable Utilization of Natural Resources - conducted by the Ministry of Environment & Forests in New Delhi during 14-15, May, 2009 - Dr. (Mrs.) Mary K. Manisseri and Dr. (Mrs.) Rani Mary George.

NAIP Annual Review Meeting under NAIP project A value chain on oceanic tuna fisheries in Lakshadweep sea" at Hyderabad during 21-22 May, 2009 - Dr.E.V. Radhakrishnan, Dr. K.S. Mohamed and Dr. V.Kripa

International Day on Biodiversity organized by NBPGR jointly by Ministry of Environment and forests, National Biodiversity Authority and ICAR at New Delhi during 21-23, May 2009 and presented a paper on Animal Biosecurity in Indian scenario - Dr. K.K. Vijayan

ICAR/NAARM sponsored special training programme on "Vigilance Administration and Management" at National Institute of Animal Nutrition and Physiology, Bengaluru during 25-27 May, 2009 - Dr. P.U. Zacharia

June, 2009

Action Plan for the research, extension and development activities' organized by the Kerala Agricultural University at College of Fisheries, Panangad on 1 June, 2009 - Dr. N.G.K. Pillai

Committee for the Registration of Fishing Vessels at Kochi on 4 June and 24 June, 2009 - Dr. N.G.K. Pillai

National Workshop on "Impact of climate change on Indian marine fisheries" at Directorate of Coldwater Research, Bhimtal during 4-6 June , 2009 - Dr. E. Vivekanandan

First International Workshop on "Assessment of fishery stock status in south and south-east Asia" at Bangkok, Thailand during 16- 19, June, 2009 - Dr. E. Vivekanandan and Dr. K.S. Mohamed

July, 2009

Review workshop on Vulnerability and Adaptation Component of Agriculture Sector of Second NATCOM (SNC) at CRIDA, Hyderabad on 2, July 2009 - Dr. V.V. Singh

Annual workshop of ICAR Network Project on Climate change at CRIDA, Hyderabad during 3-4, July, 2009 - Dr. V.V. Singh

Meeting on Conservation of Coastal Biodiversity with Dr. B.S. Corrie, IFS, Chief Conservator of Forests (Biodiversity Cell), Kerala at CMFRI, Kochi on 4 July, 2009 - Dr. (Mrs.) Mary K. Manisseri and Smt. T.S. Naomi.

Netfish interactive meeting with fishermen organizations and NGOs at Calicut and Mangalore on 8 July and 10 July, 2009- Dr.E.V. Radhakrishnan

Eighth DBT Task force meeting on 'Aquaculture and Marine Biotechnology' at the Biotechnology Department, University of Madras, Chennai during 9-10, July, 2009 - Dr. K.S. Sobhana.

Workshop on "Impact of climate change on Indian marine fisheries" organized by BOBP-IGO at Chennai during 13-14 July, 2009 - Dr. E. Vivekanandan

Workshop on Census of Marine Life (CoML), India held at the Centre for Marine Living Resources and Ecology, Kochi on 29 July, 2009. Dr. N.G.K. Pillai and Dr. P.U. Zacharia

August, 2009

Regional meeting on preparation of management plans for shark fisheries organized by BOBP-IGO at Kuldhuffushi, Maldives during 9-11 August, 2009 – Dr. E. Vivekanandan

Meeting of the chairs of QRTs, RACs and Directors of all the Fisheries Institutes of ICAR on 20 August, 2009 at CMFRI, Cochin - All the Heads of Divisions, CMFRI.

Working group for monitoring implementation and review of IOTC resolution held at Fishery Survey of India, Mumbai on 21 August, 2009 - Dr. J. Jayasankar

Intermedia Publicity Coordination Committee at Trivandraum on 24 August, 2009 - Dr. (Mrs.) Rani Mary George

National Official Language Seminar on 'Fish farming in cages' organised at CMFRI, Kochi during 25-26 August, 2009 - All Scientist of CMFRI, HQ, Kochi.

Annual Review meeting of AMAAS, Application of Microorganisms in Agriculture and Allied Sectors: Microbial diversity and Identification: Fish Microbes at NASC, New Delhi on 26 August, 2009 - Dr. Imelda Joseph

National Seminar on "Enhancing Agricultural Productivity and Profitability" organized by ICAR, New Delhi at CMFRI, Kochi during 29-30 August, 2009 – All Scientists of CMFRI HQ, Kochi.

September, 2009

Training/Workshop for Consortia Partners 'To familiarize procurement related matters and Financial Management' under the National Agricultural Innovation Project (NAIP) at Coimbatore on 3-4 September, 2009. - Dr. K.S. Mohamed

Fourth advanced programme on Cyber Laws, Information Security and Computers" sponsored by Department of Science and Technology, Govt. of India at Indian Institute of Public Administration, New Delhi from 7-13 September, 2009 - Dr. J. Jayasankar

Forty Seventh Meeting of the Academic Council of TANUVAS at Swarajya Hall, Madras Veterinary College Campus, Chennai on 16 September, 2009 - Dr. K.S. Mohamed

Half yearly review meeting for ICAR Outreach activity-3 in CIBA, Chennai on 19 September, 2009 - Dr. Kajal Chakraborty

Brainstorming Session organized under the Chairmanship of Dr. Mangala Rai, Secretary, DARE and DG, ICAR, New Delhi on Tuesday, ICF, New Delhi on 22 September, 2009 – Dr. K.K. Vijayan

Consortium Advisory Committee meeting (CAC) of the project " A value chain on high value shellfishes from mariculture systems" at CMFRI Kochi on 29 September, 2009 – Dr. V. Kripa

Meeting with Maharashtra Maritime Board regarding Rewas Port Consultancy Project at Ballard Pier, Mumbai on 30 September, 2009 - Dr. V.V. Singh

October, 2009

FAO's Second International Workshop on 'the Assessment of Fishery Stock Status in the south and south-east Asia' at Bangkok, Thailand during 5-9 October, 2009. - Dr. E. Vivekanandan and Dr. K.S. Mohamed

First meeting of the "Committee for working out the modalities to adopt a uniform validity period for both Letter of Permission (LOP) and vessel registration" held at Krishi Bhavan, New Delhi on 5 October, 2009 - Dr. J. Jayasankar

Meeting of the standing finance committee for the approval of the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" held at Krishi Bhavan, New Delhi on 7 October, 2009 - Dr. T.V. Sathianandan and Dr. J. Jayasankar

Workshop on Industry and End user meet on the Autonomous Vertical Profiler' conducted by the National Institute of Oceanography, Goa on 9 October, 2009 - Dr. D. Prema and Dr. R. Jeyabaskaran

The III Managing Committee Meeting of CARD (Centre for Aquaculture Research and Development) at the Office of the Commissioner of Fisheries, Tamil Nadu, on 15 October, 2009 - Dr. J.K. Kizhakudan

Management Development Programme on "Priority Setting, Monitoring and Evaluation for Innovation in Agricultural Research" at Indian Institute of Management, Lucknow during 19-23 October, 2009 - Dr. V.V. Singh

State level Seminar on 'Climate Changes' held at TASOSS Auditorium, Trichy, Tamil Nadu on 24 October, 2009 - Dr. R. Jeyabaskaran

Midterm Review Committee of DARE/ICAR for the 11th Five Year Plan with the Director, CMFRI at Central Institute of Fisheries Education, Mumbai on 26 October, 2009 - Dr. V.V. Singh

Fourth Aquaculture subcommittee meeting on organic farming standards organized by APEDA/ MPEDA at CIBA, Chennai on 28 October, 2009- Dr. K.S. Mohamed

Workshop on Ecopath modeling of Gulf of Mannar Ecosystem at Tuticorin RC of CMFRI during 30-31 October, 2009. Dr. T.V. Sathianandan, Dr. E.M. Abdussamad, Dr. P.S. Asha and Dr. Bindu Sulochanan

November, 2009

International Symposium on "Aquaculture, Biology and Management of commercially important Crabs - 2009' (ISABMC-2009) at Shanghai Ocean University, Shanghai, China and presented an invited paper and poster on 8-11 November, 2009 - Dr. Josileen Jose.

Winter School on Application of Molecular and Serological Tools in Fish Disease Diagnosis at CIFA, Bhubaneswar, Orissa during 9-29 November, 2009 - Dr. Satyanarayan Sethi

Research Advisory and Monitoring Committee meeting of the Botanical Survey of India and Zoological Survey of India, at the Ministry of Environment and Forests, New Delhi on 9 November, 2009 – Dr. (Mrs.) Mary K. Manisseri.

Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Kerala, Karnataka and Goa conducted at CMFRI, Kochi, during 23-25 November, 2009 - Dr. E. Vivekanandan, Dr. T.V. Sathianandan, Dr. J. Jayasankar, Dr. Somy Kuriakose, Dr. T.M. Najmudeen, Dr. K.G. Mini, Shri Wilson T. Mathew

Marine Stewardship Council meeting for MSC Certification of Tuna fishing in Indian EEZ held at CMFRI, Kochi on 24 November 2009 - Dr. E.M. Abdussamad.

December, 2009

Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Maharashtra and Gujarat, conducted at Mumbai Research Centre of CMFRI, Mumbai during 30th November to 2 December, 2009 - Dr. T.V. Sathianandan and Shri Wilson T. Mathew

National Seminar on 'Conservation and sustainability of Coastal Living Resources of India' at CIFT, Kochi on 1-3 December, 2009 - Dr. N.G.K. Pillai, Dr. K.S. Mohamed, Dr. (Mrs.) Molly Varghese, Dr. E.M. Abdussamad, Dr. Bindu Sulochanan, Dr. D. Prema, Dr. R. Jeyabaskaran and Smt. Rekha J. Nair

Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of West Bengal, Orissa and Andhra Pradesh, conducted at Visakhapatnam Regional Centre of CMFRI, Visakhapatnam during 30 November - 2 December, 2009 - Dr. J. Jayasankar and Dr. T.M. Najmudeen

National seminar on 'Climate change adaptation strategies in agriculture and Allied sectors' held at Centre for Climate Change Research, Kerala Agricultural University, Vellanikkara, Thrissur during 3-4 December, 2009 - Dr. R. Jeyabaskaran

Zonal workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" for the field staff of Tamil Nadu and Puducherry conducted at Madras Research Centre of CMFRI, Chennai, during 3-5 December, 2009 - Dr. E. Vivekanandan, Dr. V. Kripa, Dr. J. Jayasankar and Dr. Somy Kuriakose

Half yearly Review meeting of AMAAS, Application of Microorganisms in Agriculture and Allied Sectors: Microbial diversity and Identification: Fish Microbes, 17 December, 2009, CPCRI, Kasaragod, Kerala - Dr. Imelda Joseph

NFDB sponsored National training on "Cage Culture of Seabass" organized by CMFRI and delivered lecture in December, 2009 – Dr. Sathiadhas, Dr. Grace Mathew, Dr. K.S. Sobhana, Dr. Imelda Joseph, Dr. C.Ramachandran, Dr. Shoji Joseph, Dr. R. Narayanakumar, Dr. J. Jayasankar and Dr. Boby Ignatius.

January, 2010

National training on "Mud crab farming" organized by CMFRI and delivered a lecture on the topic "Water and Soil quality and Health management in mud crab farming" on 6 January, 2010 – Dr. K.K. Vijayan

Short term training programme on "Ornamental fish breeding, production and management" organized by Taraporevala Marine Biological Research Station, Bandra Mumbai on 4 January, 2010 - Dr. V.V. Singh

National Organising Committee meeting in connection with RALBAM 2010 at NIOT, Chennai during 5-8 January, 2010 - Dr. E.V. Radhakrishnan

International Conference on recent advances in lobster Biology, Aquaculture and Management (RALBAM 2010) at NIOT, Chennai during 5-8 January, 2010 – Dr. K.K. Vijayan, Dr. J. K. Kizhakudan and Dr. Margaret Muthu Rethinam

National Workshop on Fisheries conservation and Enhancement in Kerala State organized by NBFGR, Lucknow at Rajiv Gandhi Centre for Biotechnology on 6 January, 2010 - Dr. P.C. Thomas

Indaquaria 2010 organised by MPEDA at Chennai on 8-10 January, 2010 - Dr. J.K. Kizhakudan and Dr. Margaret Muthu Rethinam

AMAAS Half Yearly Review Meeting at National Bureau of Agriculturally Important Microorganisms (NBAIM), Mau, UP on 9 January, 2010 – Dr. K.K. Vijayan

Fifth Aquaculture sub committee meeting on Organic farming organized by APEDA/ MPEDA at CIBA, Chennai oduring 11-12 January, 2010 - Dr. K.S. Mohamed

Training programme on Seafood HACCP at MPEDA, Veraval on 12 January, 2010 - Dr. Shubhadeep Ghosh

Common equipment purchase committee meeting conducted by National Research Centre on Plant Biotechnology, New Delhi, under the NAIP funded project "Bioprospecting of genes and allele mining for abiotic stress tolerance" from 20–21 January, 2010 - Dr. Srinivasa Raghavan

National Seminar on challenges for sustainable management of fishery resources off Indian EEZ organized by Forum of Fisheries Professionals' at Visakhapatnam; delivered lecture on Cephalopod Fisheries of India on 20 January, 2010 - Dr. P. Laxmilatha

Workshop on 'Marine Mammal Stranding' organized and hosted by Central Marine Fisheries Research Institute, Kochi in collaboration with NOAA, USA during 21-23 January, 2010 – Dr. N.G.K. Pillai, Dr. E.Vivekanandan, Dr. K.K. Vijayan, Dr. Syed Koya, Dr. P.P. Manojkumar Dr. T.M. Najmudeen and Dr. R. Jeyabaskaran

Annual review meeting of Scientific Advisory Committee of the MoES funded project at CMLRE, Cochin during 22-23 January, 2010. Dr. N.G.K. Pillai, Dr. V. Kripa and Smt. U. Ganga.

National Workshop on IT Hardware procurement at Chennai on 28 January, 2010 - Dr. Satyanarayan Sethi

Review meeting of MoA Open sea cage culture project at CMFRI, Kochi on 28 January, 2010 – Dr. G. Gopakumar, Dr. A.P. Lipton, Dr. G. Maheswarudu, Dr. Imelda Joseph and Dr. Abdul Nazar.

February, 2010

Consultative Committee on wildlife matter convened by the Ministry of Environment and Forests, at CGO Complex, New Delhi on 2 February, 2010 – Dr. (Mrs.) Mary K. Manisseri.

Chennai Science Festival- 2010 at Periyar Science Centre of Anna University, Chennai during 3-7 February, 2010 - Dr. J. K. Kizhakudan, Dr. Margaret Muthu Rethinam and Dr. Satyanarayan Sethi

WAMAFISH 2010, on Waste Management in Aquaculture and Fisheries organized by CUSAT at Cochin during 10-11 February, 2010. Dr. N.G.K. Pillai, Dr. K.S. Mohamed and Dr. K.K. Vijayan

SAFARI (Societal Applications in Fisheries and Aquaculture using remotely sensed Imagery) training programme on *Remote Sensing and Ecosystem based Fisheries Management* held at the National Institute of Ocanography (NIO) during 11– 13 February, 2010 - Smt. U. Ganga

Consultation meet with the State Fisheries Minister on draft marine fisheries (Regulation & Management) bill 2009 at NASC Complex, New Delhi on 12 February, 2010 – Dr. E. Vivekanandan and Dr. J. Jayasankar

International seminar on 'Ornamental fish, breeding, farming and trade' organized by Department of Fisheries, Govt. of Kerala at Cochin during 13–15 February, 2010 - Dr. N.G.K. Pillai and Dr. P. Vijayagopal

DBT Task Force Meeting on 'Aquaculture & Marine Biotechnology' held at Goa University during 15-16 February, 2010 – Dr. K.K. Vijayan and Dr. P.C. Thomas

International Symposium on "Remote sensing and marine fisheries" organized by SAFARI and CIFT at Kochi during 15-17 February, 2010 – Dr. E. Vivekanandan and Smt. U. Ganga

Sixth meeting of "Working group" constituted for monitoring and review of implementation of IOTC resolutions at Krishi Bhavan, New Delhi on 15 February, 2010 - Dr. J. Jayasankar

National symposium on 'Impact of Climate Change on Aquatic Ecosystems' organized by CUSAT during 18-19 February, 2010- Dr. N.G.K. Pillai and Dr. E. Vivekanandan

March, 2010

Workshop on Integrated coastal zone management for mangrove conservation organized by National Institute of Industrial Engineering, Powai, Mumbai on 4 March, 2010 - Dr. V.V. Singh

Annual Review meeting of ICAR Outreach Projects at NASC, Delhi during 5-6 March, 2010 –Dr. P.C. Thoas, Dr. P. Vijayagopal and Dr. Kajal Chakraborty

Meeting on "Rampant killing and Trade of Marine Wildlife - evolving strategy for mitigation" convened by the Divisional Forest Officer, Malayattoor, Kodanad at Ernakulam on 3 March, 2010 – Dr. E. Vivekanandan and Dr. (Mrs.) Mary K. Manisseri.

Stakeholder consultations before finalization of the draft prepared by the Sub-Committee for consideration by the National Steering Committee on Organic Aquaculture at APEDA New Delhi on 6 March, 2010 - Dr. K.S. Mohamed

Second Meeting of the Expert Committee for Revalidation of Potential Fishery Resources in the Indian EEZ organised by FSI, Mumbai at CMFRI, Cochin on 9 March, 2010 - Dr. K.S. Mohamed

Meeting of members of revalidation of potential yield estimates in the Indian EEZ at CMFRI, Kochi on 26 November - 9 March, 2010 – Dr. E. Vivekanandan

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Veraval Regional Centre of CMFRI, Veraval during 15-16 March, 2010 - Dr. T.V. Sathianandan

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Contai field centre of CMFRI, Contai during 15-16 March, 2010 - Dr. J. Jayasankar

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Chennai Research Centre of CMFRI, Chennai during 15-16 March, 2010 - Dr. T.M. Najmudeen and Shri Wilson T. Mathew

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Manglore Research Centre of CMFRI, Mangalore during 15-16 March, 2010 - Dr. K.G. Mini.

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at CMFRI, Kochi during 15-16 March, 2010 - Dr. E. Vivekanandan, Dr. Somy Kuriakose and Dr. R. Jeyabaskaran

National Workshop on Marine Biodiversity Data Management held at National Institute of Oceanography, Goa during 17-19 March, 2010 - Dr. R. Jeyabaskaran

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Mandapam Regional Centre of CMFRI, Mandapam during 17-18 March, 2010 - Dr. T.M. Najmudeen and Shri Wilson T. Mathew

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Mumbai Research Centre of CMFRI, Mumbai during 18-19 March, 2010 - Dr. T.V. Sathianandan

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Puri field centre of CMFRI, Puri during 18-19 March, 2010 - Dr. J. Jayasankar

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Calicut Research Centre of CMFRI, Calicut during 18-19 March, 2010 - Dr. Somy Kuriakose

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Karwar Research Centre of CMFRI, Karwar during 18- 19 March, 2010 - Dr. K.G. Mini.

Review meeting NFDB Cage Culture project at CMFRI, Kochi on 19 March, 2010 - Dr. Imelda Joseph, Dr. Shoji Joseph, Dr. Dinesh Babu, Dr. J.K. Kizhakudan, Dr. Sujitha Thomas, Dr. Boby Ignatius, Dr. Geetha Sasikumar and Dr. Ritesh Ranjan, Dr. Gulshad Mohamed and Dr. M.K. Anil.

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Tuticorin Research Centre of CMFRI, Tuticorin during 19-20 March, 2010 - Dr. T.M. Najmudeen and Shri Wilson T. Mathew

The Institute Management Committee Meeting on 20 March, 2010 – Dr. (Mrs.) Mary K. Manisseri.

Second workshop under the Central Sector Scheme on "Strengthening of database and GIS for fisheries sector – Marine Fisheries Census 2010" conducted at Visakhapatnam Regional Centre of CMFRI, Visakhapatnam during 22-23 March, 2010 - Dr. J. Jayasankar.

Consortium Advisory Committee Meeting on 'A Value Chain on Oceanic Tuna Fisheries of Lakshadweep Sea' held at CMFRI, Kochi on 24 v, 2010 - Dr. N.G.K. Pillai, Dr. E.M. Abdussamad and Smt. U. Ganga

The 'International Workshop on Conservation of the Irrawadi dolphin with Special reference to the underwater acoustic study' organized by Chilika Development Authority, Bhubaneswar during 25-26 March, 2010 - Dr. R. Jeyabaskaran

Fifth meeting of the Expert Group-B on 'Conservation and Sustainable Utilization of Natural Resources' organized by the Ministry of Environment & Forests at Annamalai University during 29-30 March, 2010 – Dr. K. Vinod and Smt. Rekha J. Nair.

Workshop on 'Probable Eco-labeling initiatives by CMFRI in India' at CMFRI, Kochi under the NAIP project 'A value chain on oceanic tuna fisheries in Lakshadweep sea' on 30 March, 2010 - All Scientists at HQ, CMFRI.

NAIP sponsored International Training Programme on sand lobster seed production at Australian Instistute of Marine Sciences, Townsville, Australia during 30 March - 15 April, 2010 - Dr. J.K. Kizhakudan

Cruises

Cruise No. 271 of FORV Sagar Sampada along south-east coast of India (Cochin- Vishakapatnam - Tuticorin) during 26 August - 12 September, 2009 - Dr. R. Jeyabaskaran

Fellowship

Biotechnology Overseas Associateship Award 2007-08 for a period of six months at Aquaculture Department, School of Marine and Tropical Sciences, James Cook University, Australia during 25 October, 2008 to 10 May, 2009 - Dr. Josileen Jose.

Netherlands Fellowship (NUFFIC) from the Government of Netherlands and attended a course on "Fisheries data collection and analysis" at Wageningen International, The Netherlands during 2-20 November, 2009 - Dr. Sujitha Thomas.

Women Cell

- As an integral component of health care programmes envisaged for the staff of CMFRI, the Women Cell organized regular *yoga* sessions for three months from 4.30 pm onwards. The meditation class on Wednesdays from 1300 to 1320 hrs. was also inclusive of this endeavour and both were conducted under the expert guidance of the resource personnel, Ms. K. Smitha, Stenographer Gr. III of CMFRI.
- A cookery class was organized in association with Krishi Vigyan Kendra, Narakkal on "Preparation of value added products from fruits (squash, mixed fruit jam and tomato sauce)" for CMFRI staff and their family members at the CMFRI Residential Quarters, Thevara on 21st June, 2009. Smt P. Sreelatha, Technical Officer, KVK, demonstrated and imparted the cookery skills to the gathering.
- A demonstration cum training session for lady volunteers of CMFRI staff, to check blood pressure was conducted by Dr. V.P. Vipinkumar, Senior Scientist on 12.11.2009. The trained volunteers would take turns to check the blood pressure of the needy lady staff members on Fridays during 1315-1330 hrs.
- A seminar was organized in connection with the observance of the International Centenary Women's Day, on 8th March, 2010 at 1430 hr in the CMFRI Auditorium. Presidential address was given by Dr. G. Syda Rao, Director, CMFRI. The Chief Guest, Dr. Sitalakshmi George, a well known personality in child psychiatry (Associate Professor, Malankara Orthodox Syrian Church Medical College, Kolencherry) delivered a talk on a subject of topical interest, "Parenting Skills". Staff and research scholars of CMFRI, NBFGR and CIFRI attended the meeting and participated in the discussions which focused on the present day problems involving children and parents.

Dr. Sitalakshmi speaking on Parenting Skills
on International Women's Day

Distinguished Visitors

- Dr. Mangala Rai, Secretary, DARE and DG, ICAR, visited Veraval RC of CMFRI – April 8, 2009.
- Dr. S. Ayyappan, DDG, (Fy), ICAR, New Delhi, visited Mangalore RC of CMFRI – May 7, 2009.
- Dr. Ajithkumar, Central Vigilance Officer, ICAR, visited the Marine Research Aquarium, Calicut RC of CMFRI – May 26, 2009.
- Shri. M.A. Upare, Ex.General manager, NABARD visited Mangalore RC of CMFRI – July 15, 2009.
- S.P. Rajalingam, Postmaster General Southern Region, Madurai, visited Mandapam RC of CMFRI - July 18, 2009.
- Shri. N.K. Prasad IAS, Commissioner of Fisheries, Andhra Pradesh, visited Visakhapatnam RC of CMFRI – July 23, 2009.
- Dr. Mangala Rai, Secretary, DARE and Director-General, ICAR visited Madras RC of CMFRI. Dr. Mangala Rai released the video CD of CMFRI on the deployment and monitoring of the artificial reef structures at selected 11 sites off Tamil Nadu in a function jointly organized by CMFRI and CIBA. Dr. S. Ayyappan, DDG (Fy), Dr. G. Syda Rao, Director, CMFRI, Dr. A.G. Ponnaiah, Director, CIBA and the Vice Chancellor, TANUVAS were present on the occasion - September 5, 2009.
- Shri. Dilip N. Pagdhare, Chairman, Mahim Machhimar V.K.S. Society Ltd., Mumbai and Shri. Narendra R. Patil, General Secretary, Maharashtra Machhimar Kruti Samitee, Satpati, Maharashtra visited Visakhapatnam RC of CMFRI – September 8, 2009.
- Shri. Sanjay Koli, Chairman, Vasai Machhimar Sarvodaya Sahakari Sangh visited Mumbai RC of CMFRI – September 24, 2009.
- Dr. B.N. Chattopadyaya, Coordinator and Nodal Officer, Media & Information Unit, ICAR, Krishi Bhavan, New Delhi, visited Calicut RC of CMFRI – November 9, 2009.
- Dr. N. Basavaih, Indian Institute of Geomagnetism, Panvel, visited Mumbai RC of CMFRI - November 13, 2009.
- Dr. Ulrich Blanka of University of Tubingen, Germany, visited Mumbai RC of CMFRI – November 13, 2009.
- Shri S.G. Patvari and other staff of Fishery Survey of India visited Mumbai RC of CMFRI - December 10, 2009.
- Dr. Krishna Srinath, Director, Directorate of Research on Women in Agriculture, Bhubaneswar, Orissa visited Calicut RC of CMFRI - December 22, 2009.
- Shri. B.L. Gautam, Inspector General of Police, Shillong, Meghalaya visited Calicut RC of CMFRI – December 27, 2009.
- Shri G.S. Mehata, General Manager, NABARD, Mumbai visited Mumbai RC of CMFRI – January 2, 2010.
- Dr. Aruna Basu Sakar, IFS, Trust Director, Gulf of Mannar, Biosphere Reserve Trust, Kenikarai, Ramanathapuram visited Kovalam Field Laboratory of the Madras RC of CMFRI – January 9, 2010.
- Dr. K.K. Kumar, Director, NRC for Litchi, Musafarpur, Bihar visited Calicut RC of CMFRI – January 14, 2010.
- Dr. P.S.B.R. James, former Director, CMFRI visited Visakhapatnam RC of CMFRI – January 21, 2010.
- Shri. Manmohan Singh, IAS, Commissioner of Fisheries, Andhra Pradesh, visited Visakhapatnam RC of CMFRI – January 28, 2010.
- Dr. Usha Goswami, Director, Marine Bioresource Centre, Jamnagar, visited Veraval RC of CMFRI - January 23, 2010.
- Dr. N.K. Tyagi, Member, ASRB, visited Veraval RC of CMFRI – February 2, 2010.
- Dr. Madan Mohan, Assitant Director General (M. Fy), I C A R, New Delhi, visited Mandapam RC of CMFRI – February 8, 2010.

- Honorable Minister of State for External affairs and the Member of Parliament (Thiruvananthapuram) Dr. Shashi Tharoor and Shri. George Mercier, MLA Kovalam assembly constituency visited CMFRI Aquarium, Vizhinjam - February 10, 2010.

Dr. Mangala Rai, Secretary, DARE and
DG, ICAR releasing Video CD at Chennai RC of CMFRI

- Dr. Arun Kumar, Deputy Director General, (Fisheries) ICAR, New Delhi, visited Madras RC of CMFRI – February 11, 2010.
- Dr. S. Lazarus, D. Sc., Emeritus Professor (UGC) CMST, M. S. University, Tamil Nadu visited Madras RC of CMFRI - February 15, 2010.
- Dr. Nariwadekar and 21 trainee vigilance officers from ICAR, New Delhi visited Calicut RC of CMFRI – February 23, 2010.

Hon' Minister Dr. Shashi Tharoor and Shri. George Mercier, MLA
at Vizhinjam RC of CMFRI

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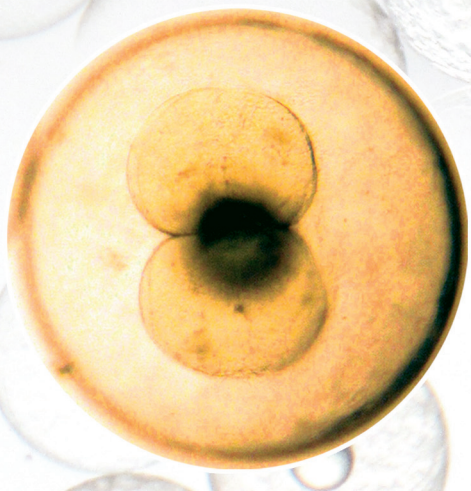

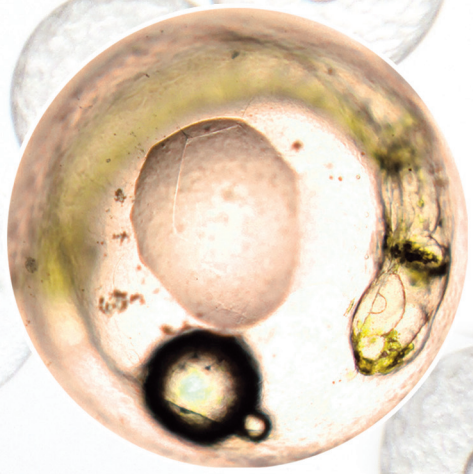

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